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AGRICULTURAL ENGINEERING

The Journal of the American Society of Agricultural Engineers

DECEMBER 1934

VOL 15 NO 12

ASAE

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AGRICULTURAL ENGINEERING

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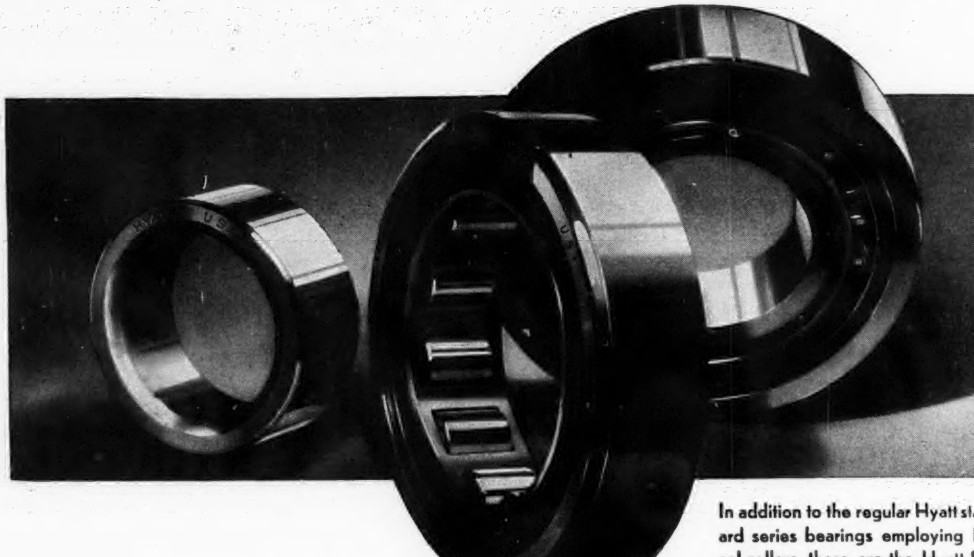
BUILDING BETTER



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HYATT

ROLLER BEARINGS

PRODUCT OF GENERAL MOTORS

A Study of Suitable Equipment for Applying Sulphuric Acid for Weed Control

By O. C. French[1] and W. E. Ball[2]

THE Crop Protection Institute, cooperating with the University of California agricultural experiment station and the California state department of agriculture, has carried on the past year a project involving the use of sulphuric acid as a herbicide. The experiments have been particularly impressive in the control of wild mustard in cereal crops (Fig. 1). As high as 96 per cent of the mustard has been killed in barley fields experimentally (not on an acreage basis); and the yield in some cases has thus been increased as much as 60 per cent.

In foreign countries the practice of spraying with dilute sulphuric acid for weed control is already well established.

The problem of spraying dilute sulphuric acid, which is highly corrosive to metals, has long been recognized. According to a report in "Chemical Markets" for September 1933, however, at least 20 manufacturers in France are making suitable spray equipment, mostly for small acreages. The equipment now being used for the experimental work in California consists of a lead-lined storage tank, an all-bronze pump, and brass connecting pipes and boom. Although this apparatus (Fig. 2) has successfully withstood the corrosion of the dilute acid, the initial expense of such equipment of suitable size for commercial application would be beyond the means of many grain growers.

Best results have been obtained in California where a 10 per cent solution (by weight) of sulphuric acid was used at the rate of 120 gal per acre. A pressure of 75 lb per sq in at the nozzles seemed adequate to give desired coverage.

The Development of Machinery

The object in developing a sulphuric-acid sprayer was to eliminate the necessity of pumping the dilute acid. A pump constructed of acid-resistant metals could be obtained, but at a much greater cost than ordinary spray pumps. In order to save on the original investment, as well as on maintenance costs, it seemed essential to use some auxiliary device for injecting the concentrated acid into water in the discharge pipe between the pump and the spray boom. To accomplish this purpose the plan was to use a venturi tube or injector.

The device originally suggested was a specially designed brass venturi tube. After some preliminary trials with a Penberthy steam ejector, however, the venturi tube was abandoned because one of suitable size was not commercially available, whereas the steam ejectors can be purchased in small sizes for as low as $2.50.

In the experiments with the Penberthy steam ejector on a portable orchard sprayer, the following set-up was used: The pump was a Bean triplex, with a capacity of about 16 gal per min. A 16-ft boom fitted with Chipman nozzles with No. 4 disks was connected to the pump (Fig. 3). In the discharge pipe at a point 3 ft from the boom a No. 62 Penberthy ⅜-in steam ejector was installed (Figs. 4 and 5). A ¾-in pipe, placed in a container for the concentrated acid, was connected to the suction side of the ejector. A union was placed in this ¾-in pipe to hold disks with orifices varying in size from ¼ to ⅛ in to control the amount of acid drawn into the ejector.

With this set-up the pump and piping system handled

[1]Instructor in agricultural engineering, and junior agricultural engineer in the agricultural experiment station, University of California. Jun. A.S.A.E.

[2]Investigator, Crop Protection Institute.

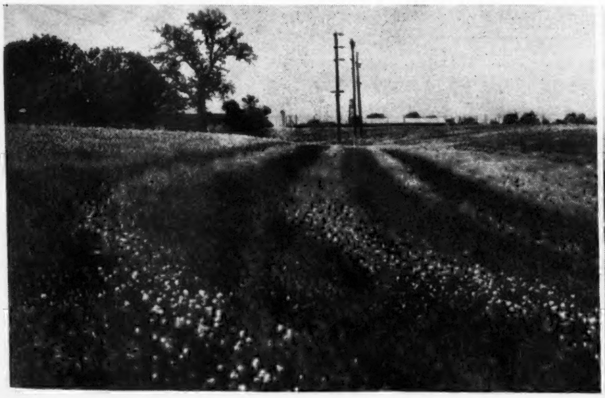
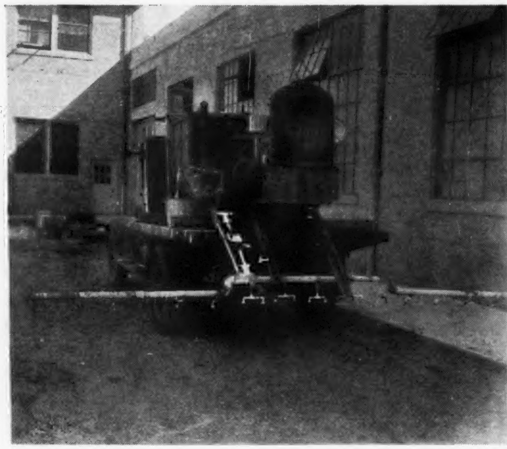


FIG. 1 (ABOVE) RESULTS OF SPRAYING MUSTARD-INFESTED BARLEY WITH DILUTE SULPHURIC ACID. THE PICTURE WAS TAKEN TWO WEEKS AFTER SPRAYING SHOWING BLOOMING MUSTARD IN UNSPRAYED AREAS. FIG. 2 (RIGHT) EXPERIMENTAL MACHINE USED DURING 1934 SEASON IN CALIFORNIA FOR SPRAYING DILUTE SULPHURIC ACID



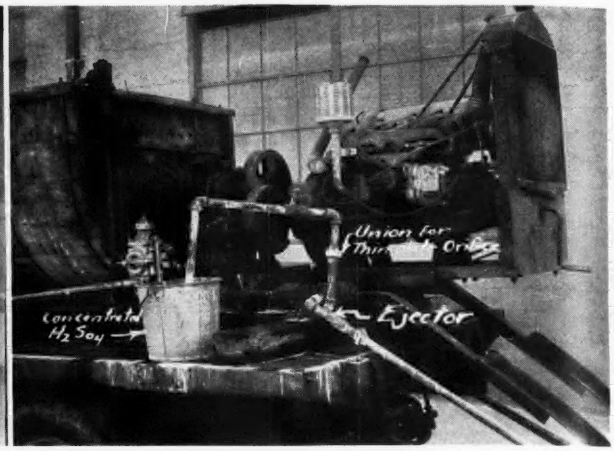


FIG. 3 (LEFT) ORCHARD SPRAYER EQUIPPED WITH PENBERTHY STEAM EJECTOR AND BOOM FOR APPLYING DILUTE SULPHURIC ACID. FIG. 4 (RIGHT) VIEW SHOWING LOCATION OF EJECTOR IN DISCHARGE LINE OF SPRAY PUMP

only water up to the point of the ejector. Nozzles were placed on the boom until the pressure differential between the pump and boom was sufficient to create less than atmospheric pressure at the suction side of the ejector.

The acid content of the solution discharged from the boom was determined by catching samples from the nozzles and determining the specific gravity of the solution by use of the Brix spindle hydrometer. This method, when corroborated by weighing the input of acid, proved to be very accurate. By taking samples at different nozzles on the boom, the uniformity of mixture was confirmed. All acid used was commercial sulphuric acid, 66 deg Baume.

The per cent of acid was determined for varying rates of discharge for three sizes of thin-plate orifices in the ejector suction line, namely, 1/4, 3/16, and 1/8-in diameter. For each orifice tested, nine rates of discharges were obtained by using pressures at the boom nozzles of 52, 62, and 72 lb per sq in for 9, 10, and 11 Chipman nozzles equipped with No. 4 disks.

The results of these tests are shown in Table 1 and also graphically in Fig. 6. For a given ejector, according to these data, acid concentration as low as 2.2 per cent to as high as 16.5 per cent could be obtained by changing the size of suction orifice and the quantity of spray-boom discharge.

The concentrated acid mixed almost instantaneously with the water in the throat of the ejector. Since the viscosity of the concentrated sulphuric acid varies greatly with the temperature, it was at first believed that this factor would complicate the problem. Concentrated sulphuric acid varying in temperature from 8 to 40 deg C was run through the ejector; the concentrations determined at the nozzles showed less than 1 per cent differences, so that the viscosity factor can be eliminated.

Pressure-capacity tests were run on No. 4, No. 3, No. 2, and No. 1 Chipman nozzle disks. Calibration curves for each disk are shown in Fig. 7. This information is valuable in case one wishes to equip a spray boom with other than Chipman No. 4 disks, with which all tests were made. Suppose, for example, one wanted to fit a boom with No. 3 disks to get a finer spray, and desired a 10 per cent acid concentration. With the conditions under which the data in Table 1 were obtained, 10 per cent acid concentration resulted when ten No. 4 disks, 62 lb per sq in pressure at the nozzles, and a 3/16-in orifice were used. As shown by Fig. 7, a No. 4 disk delivers 1.21 gal per min; ten nozzles would deliver 12.10 gal per min. Since a No. 3 disk delivers 0.90 gal per min at 60 lb per sq in, it would take 12.10/0.90, or 13.5 No. 3 disks to deliver the same quantity as ten No. 4 disks. Fourteen No. 3 nozzles would then be installed.

The spacing of the nozzles on the boom will vary with the height of the boom from the ground and also as to the amount of overlapping of the spray.

CONCLUSIONS

This study shows that it is feasible to use an ejector in connection with an ordinary spray pump to handle acid solutions, thus eliminating the corrosive effects of acid on the working parts of a pump.

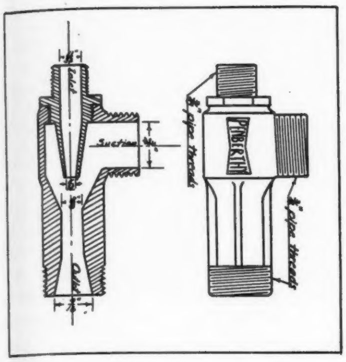
A large range of acid concentrations can be obtained by minor adjustments.

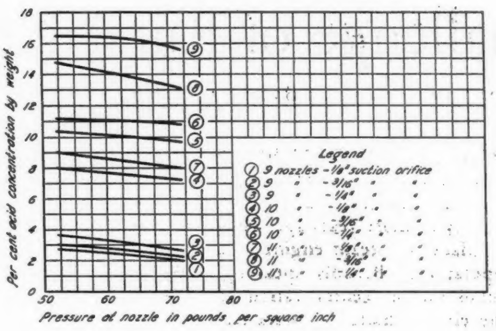
All pipes, pipe fittings, and nozzles coming in contact with dilute sulphuric acid must be of brass. Pure nickel or

TABLE I. RESULTS OF TESTS EMPLOYING VARIOUS PRESSURES, SUCTION ORIFICES, NUMBER OF NOZZLES, AND ACID CONCENTRATIONS*

Run No.	Pump pressure, lb	Nozzle pressure, lb	Number of nozzles	Diameter of suction orifice, in	Per cent acid concentration
1	200	72	9	1/4	2.8
2	160	62	9	1/4	3.0
3	130	52	9	1/4	3.7
4	210	72	10	1/4	10.4
5	175	62	10	1/4	11.1
6	150	52	10	1/4	11.2
7	230	72	11	1/4	15.6
8	200	62	11	1/4	16.4
9	160	52	11	1/4	16.5
10	190	72	9	3/16	2.2
11	160	62	9	3/16	2.7
12	140	52	9	3/16	3.0
13	210	72	10	3/16	9.7
14	175	62	10	3/16	10.0
15	150	52	10	3/16	10.4
16	240	72	11	3/16	13.0
17	200	62	11	3/16	14.0
18	160	52	11	3/16	14.8
19	200	72	9	1/8	2.0
20	160	62	9	1/8	2.4
21	130	52	9	1/8	2.8
22	215	72	10	1/8	7.3
23	185	62	10	1/8	7.6
24	150	52	10	1/8	8.0
25	240	72	11	1/8	8.0
26	200	62	11	1/8	8.5
27	160	52	11	1/8	9.0

*All tests were made with No. 4 Chipman disks.





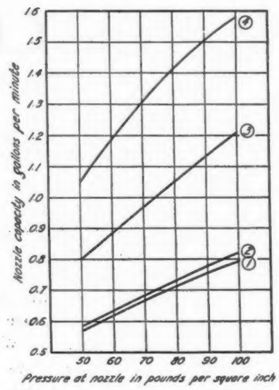


FIG. 5 (LEFT) DETAILS OF THE NO. 62 PENBERTHY ⅜-IN STEAM EJECTOR USED IN THE CALIFORNIA STUDY OF SPRAYING DILUTE SULPHURIC ACID. FIG. 6 (MIDDLE) RESULTS OF TESTS FOR DILUTE ACID CONCENTRATIONS WITH PENBERTHY EJECTOR. FIG. 7 (RIGHT) CALIBRATION CURVES FOR CHIPMAN NOZZLE DISKS NOS. 1, 2, 3, AND 4

monel metal spray-nozzle disks, however, are practically acid proof and superior to brass.

As a precaution, a check valve should be placed in the pipe on the suction side of the ejector, for, if a sufficient number of nozzles on the boom should clog, the pressure differential between the pump and the boom would drop, causing water to be forced back through the suction side of the ejector into the concentrated acid. As a result, considerable heat would be generated in the acid container and would also cause the concentrated acid to be diluted.

Man as a Power Unit

By Frank J. Zink[1]

RECENTLY it has been pointed out that labor is only a humanly derived service. Power, on the other hand, may be obtained from several units including man as a source of power. Man as a power unit has been lifted in status along with the development of civilization. Civilization has dignified the output of man by giving it the name "labor," although in many cases the output of man cannot be construed as anything but power.

In the days of the galley slave, and still in China for the pumping of irrigation water, man could be considered as being little else than a power unit. Apparently as a power unit, man is at his best when using the major muscles of the body. There is little reference to be found to show how man can best use his strength in the production of power. In many tasks performed at present the work might more easily be done by using better engineering methods. With better engineering methods of using man as a power unit, the efficiency of the Chinese, with their treadwheel irrigation water pump, could be approached. The twentieth century man with a shovel could produce several times the number of foot-pounds of work, and the man turning the crank could produce some sixty per cent more power.

For support for this expression and for some interesting information, attention is directed to F. J. Jervis-Smith's book on dynamometers[2] as follows:

"Coulomb investigated with great care the conditions under which men best performed work (Memoires de l'Institut National des Sciences et Artes: Coulomb, 'Science, Math. et Phys.,' T.II.). His work is commented on by Poncelet in his 'Mecanique industrielle'; Paris, 1841, p. 237. The table exhibited by Poncelet, taken from the results of Coulomb, is most instructive, as it is a summary of his experiments, made with great care and extending over many years of observation. The following translation describes one of the most remarkable discoveries of Coulomb:

" 'Concerning the best method for utilizing the strength of man, the table shows that the greatest amount of work which a man can yield per day without undue fatigue consists in raising his own body, and this equals 280,800 kilogram-metre units of work in eight hours. Since the kilogram-metre = 7.233 foot-pounds, 280,800 kilograms = 2,031,026 foot-pounds in eight hours, or 4,231.2 foot-pounds per minute, so that the rate of doing work was 0.128 horsepower—a result at least seven times that of a simple worker with a shovel, and one which surpasses by nearly two-thirds that of a workman employed in turning a winch handle. In order to utilize that amount of work at disposal there is no question, as Coulomb observes, but to make use of the descent of the weight of the man in raising a weight equal to his own to the height which he reaches each time, i.e., each journey. Amongst the contrivances devised to fulfill this end the most simple, and that which has been practically used by Captain Coignet in the construction of the earthworks of the fort of Vincennes, near Paris, consisted of a rope passing over a pulley, furnished at its ends with boards, one of which carried the man and the other the weight to be raised. These operations, in which each workman raised the weight of his own body (70 kilograms) 310 times daily to the height of 13 metres, have been thoroughly authenticated.'

"The process will perhaps be better understood if we imagine a grooved pulley, running on a horizontal axle fixed at the top of a building, furnished with a rope having its lower end attached to the load to be raised. The workman ascended the building by steps, and when at the top he seated himself on a board attached to an upper portion of the rope, the load being a little less than the weight of the man; he then descended regulating the rate of descent as he pleased, by handling the rising portion of the rope (which would be itself in equilibrium if continuous) until he reached the ground. Before he left his seat the load at the top would be removed, another man would take its place, and the man below who had made the descent would be replaced by the next load, which would ascend in the same manner. At the same time the first man would be walking up again to the top of the building, to be ready for the next load."

[1]Associate professor of agricultural engineering, Kansas State College. Mem. A.S.A.E.

[2](1915) D. Van Nostrand Co., N. Y.

The Challenge of Rural Electrification[1]

By E. A. White[2]

IN DISCUSSING the challenge of rural electrification it is well to remember that the extension of electric service into the country is the logical culmination of a great movement which started forty or more years ago when the electric motor began to supplant the steam engine as a prime mover for industrial operations. Broadly speaking, the steam engine was the symbol for the centralization of industrial operations, while the electric motor is characteristic of decentralization. We are just beginning to realize that the electrical age means not only decentralization of industrial activity, but also a nationwide diffusion of a marked improvement in the standard of living for all groups and classes of our population. The possibilities are so tremendous that only after more than forty years of development is there beginning to be a general realization of what electric service means to the people of a nation.

Now what is the challenge presented to us? From this standpoint our present rural electric development, over ten years in the making, may well be looked upon as a great national laboratory in which every conceivable idea that human ingenuity can devise is being or will be tried out to determine its worth to society. Giving every credit to the splendid developmental work already done, we must not allow ourselves to think that possibilities in this direction are exhausted. The engineer and inventor are in no humor for extended vacations and will push forward to new conquests. If the results from this laboratory are what we expect, rural electric service is just starting. Therefore the great challenge lies in the question: What will electric service do for rural America?

In discussing possible answers to this question some facts can be drawn from experience. In such cases our problem is to properly evaluate what these facts mean when interpreted in terms of the future. In other cases we take the possibilities embodied in electric service and draw upon our imagination, our judgment, our experience in other lines of activity in an effort to properly evaluate or determine what courses of action will be the most desirable.

One possibility resulting from the introduction of electric service into rural areas is the opportunity afforded to materially improve living conditions or living standards. With electric service it is possible today to make a rural home, a farm home, just as modern and convenient as any urban home. In other words, you do not have to move to town to enjoy home modernization. This can be set down as a fact. What it may mean in our national development is something else. My guess is that it may have far-reaching consequences. In the first place, it will encourage farm owners to remain on the farm instead of selling out for the purpose of moving to town. This will tend to give us more mature farm operators with less opportunity for young men to acquire control of land. Thus there may be both advantages and disadvantages in this phase of rural electric development. There will be a call for more capital investment in our farm areas. In place of saving money with which to move to town, these savings will be invested in improvements as accumulated. This will tend to depress urban real estate values and increase the demand for equipment and materials with which to improve rural dwellings. This one theme could be enlarged into an entire paper. Suffice it to say there are prospects of a great national movement extending over a decade or longer which will see our rural homes completely modernized. Such a development will call for the expenditure of millions of dollars, and could well be one of the important factors in our next economic cycle. We can well ponder over what these possibilities for rebuilding rural America really mean.

Rural electric service takes more than the possibility for improved living conditions into the country. It makes available a convenient, safe, reliable, and economical source of energy for practically all stationary operations. It gives the farmer the same opportunity to use power as the urban centers have enjoyed. Thus we not only have a new prime mover for such operations as pumping water, grinding feed, filling silos, hoisting hay, or sawing wood, but we have a source of energy from which we can obtain both heat and refrigeration. This opens up new and interesting possibilities.

Take refrigeration, for example. The place to begin the cooling of perishable products such as milk, fruit, or eggs is on the farm. We can look forward to a tremendous increase in our farm refrigeration load. It does not require any great amount of imagination to visualize an American agriculture with practically all whole milk sold for urban consumption cooled by the use of electricity, large storage plants for fruit and vegetables, refrigeration for eggs and other poultry products on the farm. Such developments will not only even out the marketing season but greatly improve the quality of the products.

In our humid regions we can expect a marked increase in irrigation. Already this is an established and profitable practice for vegetable production. We can expect it to increase very rapidly, including in its scope also fruits and pasture.

Electric service has invaded the field for the use of heat in farm operations. This includes heating water, incubation, brooding, soil heating, and soil sterilization. It is giving splendid satisfaction, and the present use is only a beginning. In many cases this means a reduction in the man-hours required for farm operations, thereby making it possible to produce and market our agricultural products with a decreasing percentage of our total population. In other cases introducing new processes on to the farm may require more labor. Taken as a whole, however, the more mechanical prime movers on our farms, the less the labor required. This is one of the cardinal points in the philosophy of the engineer, who believes that a nation which can produce the necessities and luxuries which society demands with a minimum of labor requirements is fundamentally well off.

Here again our entire time could be spent upon this phase of the situation. Suffice it to say the conditions indicate a marked increase in the use of electrical energy for stationary farm operations. It is just another step in modernizing American agriculture, thus affording another great outlet for urban labor to produce the equipment needed and for capital to place this equipment on the farms.

The introduction of electric *(Continued on page 418)*

[1]Paper presented before a meeting of the North Atlantic Section of the American Society of Agricultural Engineers, at Amherst, Massachusetts, October 1934.

[2]Director, Committee on the Relation of Electricity to Agriculture. Charter Mem. A.S.A.E.

Some Requirements for Extending Farm Electrification[1]

By R. B. Gray[2]

ONE OF THE MOST generally accepted indications of business activity has been the barometer afforded by the steel industry. However, there now appears to be another at least equally authentic barometer for feeling the pulse of business — that of the electrical power industry with its rise and fall of kilowatt-hour output per week according to conditions. By this industry not only can the national pulse be felt, but the situation in various sections can be equally well reflected.

With the rapid spread of the use of electricity in rural areas and the increasing desire for electric service by the farmers, the kilowatt-hours consumed for agricultural purposes will have its influence felt more and more in this business indicator.

To get a more definite picture of the situation, a national survey of limited scope of the U. S. Department of Agriculture, as a supplement to the CWA Farm Housing Survey was made last spring under the direction of Mr. Geo. W. Kable, supervising engineer. The material for this paper was largely drawn from Mr. Kable's report on this survey.

For administrative purposes and for obtaining data in the field, housing survey personnel was drawn upon. State supervision without cost was provided by the land-grant colleges through their extension divisions and departments of agricultural engineering. Data to be obtained were decided upon jointly by Mr. Kable and other representatives of the USDA Bureaus of Home Economics and Agricultural Engineering; Dr. F. S. Warner, head of the division of research, National Power Survey, and Prof. Chas. E. Seitz, head of the agricultural engineering department, Virginia Polytechnic Institute, and a past-president of the American Society of Agricultural Engineers.

The purposes of the survey, other than to give employment, were to obtain information supplemental to data from the housing survey, federal census, and other sources, relative to the present availability of electric service to farmers, its use, and the possibilities of extending service to additional farms. Other purposes were to foster local interest in improved farm living conditions and in rural-line construction which would give employment to workers. The data collected are to be made available to the Public Works Administration and to any organization which can use them for the benefit of the public.

Twenty-five states were included in the survey. The states selected were those in which supervisory personnel was available. Work was started in most of the states about March 15 and ended officially on May 28. The areas covered in each state varied from one township to a partial survey of forty-two counties. The average number of counties studied per state was 4.5. The summary given in this report includes data from nineteen states. Three state reports have not yet been received and data from three other states were not sufficiently complete to tabulate. The surveys are being continued to get additional information in Illinois, Iowa, Massachusetts, Maryland, North Carolina, Oregon, Virginia, and Washington.

A major part of the information submitted by the states applies only to specific localities and cannot be tabulated in a national summary. Such information includes the following (not complete for every state):

1 State maps showing (a) transmission lines and generating stations, (b) existing and proposed rural distribution lines, (c) territory served by different utilities, (d) types of agriculture, and (e) forested areas

2 County or township maps showing (a) existing distribution lines, and (b) proposed distribution-line extensions and locations of possible customers

3 Brief descriptions of existing rural-distribution lines

4 Lists of the proposed distribution-line extensions in the order of estimated feasibility and with descriptions of the territory, types of farms, construction problems, possible load, and available electricity supply

5 Rate schedules and line-extension policies of companies serving rural areas.

6 Specific examples of monthly and yearly power consumption of different types of rural users

7 Data on cooperatively-owned lines, laws affecting cooperatives, interest of local groups in electric service, etc.

This survey is intended primarily to give a picture of the possibilities of extending electric service to farms throughout the United States. It includes sufficient areas of wide enough geographical distribution to give an indication of the situation in the country as a whole. Figures pertaining to specific areas are reasonably accurate. The speed with which this survey was made and compiled did not permit careful checking in all cases. The county maps with present and proposed distribution lines shown in colors, together with the supporting data, are adequate for making preliminary appraisals and programs for the territory involved. More detailed examinations would be necessary before making construction cost and feasibility estimates.

Original copies of survey reports and maps submitted by the states are on file in the Bureau of Agricultural Engineering, U. S. Department of Agriculture. A mimeographed summary of these reports, entitled "Report on CWA National Survey of Rural Electrification" is now available.

Electric service to farms in the United States in the 1930 U. S. census report indicates that 10.3 per cent of the farms had central-station service, and 4.0 per cent had individual lighting plants. The average annual power consumption per farm varied from 198 kwh (kilowatt-hours) in Arkansas to 15,868 kwh in Arizona, and the average annual bill paid to the power companies ranged from \$37.60 in Utah to \$251.00 in Arizona. Relatively few motors were used in the south-central group of states. On the Pacific Coast and in the Southwest there was exten-

[1]Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers at Amherst, Massachusetts, October 1934.

[2]Chief, Division of Mechanical Equipment, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Mem. A.S.A.E.

sive use of motors, with accompanying larger power consumption and lower average rates. The use of motors is indicative of a farm power load in distinction to a load made up largely of lighting and domestic appliances.

On the Pacific Coast the power load consists mostly of pumping for irrigation and drainage, with some increment in heat and power for fruit, nut, and hop driers.

In California and Arizona where irrigation by pumping prevails, the average annual power consumption per farm was 14,792 kwh at a cost of about 1.45 cents per kwh. In the group of west south-central, mountain, and Pacific states the average annual consumption was 7080 kwh costing approximately 1.76 cents per kwh, while the average for the remainder of the United States was only 746 kwh per year per farm, and the cost about 8.17 cents per kwh. These figures, while not exact, give a very good idea of the relation of large use to low unit costs.

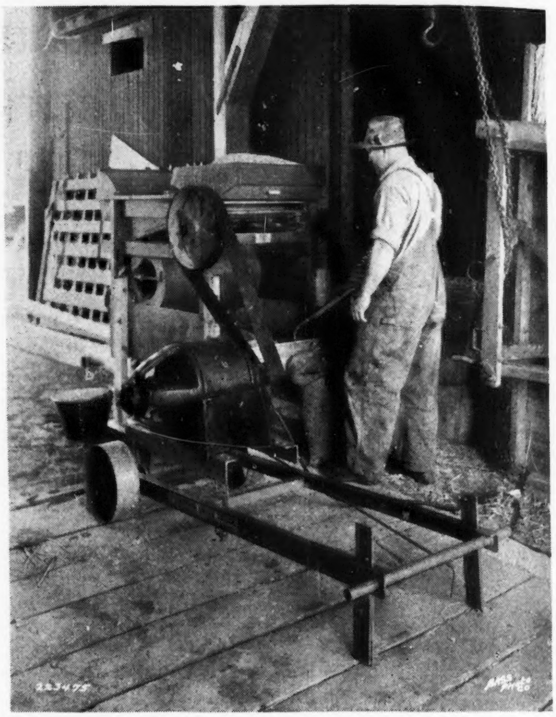
Figures taken from NELA Publication No. 237, August 1932, and Rural Electrification Exchange, No. 2, March 1, 1934, issued by the Edison Electric Institute show that the percentage of farms receiving central-station service increased from 2.8 to 11.3 in ten years, but that there are still nearly eight times as many farms without service as with it.

An analysis of the distribution of farms having central station service on December 31, 1933, places the heavy percentages of farms in the North Atlantic and Pacific Coast sections and in Utah. The eastern development is due probably to the large number of industrial cities and towns with their inter-city distribution network, and to the proximity of rural users. Both factors tend to reduce the cost of bringing the service to the farm. On the Pacific Coast, service has been extended to farms largely because of the farm use for power, and independent of other industries. This power load is a most effective stimulant to rural service. It is an income producing use for the farmer, insures a load worth building a line to serve, and permits lower rates which are attractive to the user.

The areas in which active efforts are being made to further develop rural service include California, Washington, Oregon, and Idaho in the west, and South Dakota, Nebraska, Kansas, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania, New York, Vermont, New Hampshire, Massachusetts, Maryland, Virginia, North Carolina, South Carolina, Tennessee, and Alabama in the eastern half of the United States. In the western states and in the greater part of the eastern states educational efforts by the agricultural colleges and promotional work by the utilities have been carried on. In the western states, the activity has been largely in the development of more productive uses for electricity. Some of California's irrigation pumping load has been lost to cheap natural gas and to oil engines but efforts have been renewed in other directions. The middle western states are experiencing a slow but steady increase in use. In this section relatively few economical uses for large amounts of electricity on farms have as yet been developed and rates are consequently higher than elsewhere. The North Atlantic section and Virginia have had active educational and sales campaigns for several years. Farms are closer together and rates are generally lower.

At present a noteworthy committee appointed by Governor Ehringhaus is at work on the development of rural electric service in Connecticut with the state's relief program.

Michigan has led the country for several years in the number of farm customers added to those receiving service. The average farm rate (4.6c per kwh) for 1932 is reported to be the lowest for any state east of the Mississippi River. The increase in customers served is due probably to the lower rates and the very excellent educational and development programs of the state agricultural college and the larger utilities.



North Carolina apparently has a very active interest in rural electrification emanating from the farmers. Several farm lines were built as CWA projects.

South Carolina has made an extensive survey of rural electrification possibilities in the state and has enacted legislation "to establish a system of rural electrification under state control." The State Highway Department is constituted a state board of public utilities, and rural service is to be coordinated with highway lighting. Application has been made for a PWA loan for rural-line construction.

Cheaper Power Available in the Tennessee River Basin

The Tennessee River basin is to be supplied with cheap power by the federal government. Power will be distributed by cooperative distribution organizations buying from the government. Federal assistance is being given in educational and organization work, and in making available low-cost equipment and low-interest-bearing bonds for the purchase of equipment and appliances.

Farmers generally want electric service. Many of those who do not now have it would have it if the cost were lower, or if their cash income were larger. Many others would have it if they knew how to use electricity to increase the returns from their farming operations. In order to serve the others the many obstacles of that service must be removed. Each obstacle removed opens the possibilities of electricity to a new group of rural users, or permits the use of electricity for additional farm purposes. Opportunities for expansion involve such factors as farm cash income, rates and service charges, rate forms, line-construction costs, line-extension policies, equipment and equipment costs,

wiring costs, financing, supplemental rural industries, research, education, and sales.

Whether a farmer asks for electric service or is being urged to buy it, he is a prospective customer. Customers today buy the things which are put up in attractive packages and offered at appealing prices. Too much of our electricity is offered in a take-it-or-leave-it package with labels which cannot be read or understood.

The farmer's position and viewpoint is different from that of the industrialist and different from the city domestic user. The selling approach to the farmer must also be different. It should be based upon the farmer's point of view—and be sure it is the farmer's actual viewpoint and not the one the utility thinks he should have.

The farmer's expenditures must be adjusted to his relatively limited cash income. The barn is usually built before the house. The barn shelters horses and cows and feed for them, and the horses and cows add directly or indirectly to the farm income. The income from the cows builds the house. More attention should be given the income-producing uses of electricity; they need more attention. They need demonstration, trial, and use in the community, with data as to monthly net balances over costs. So far, the use of electricity for convenience and pleasure on farms has been largely an about-face movement of the farmer—an out-of-pocket expense in place of an income-producing investment.

The Relation of Power Rates to Increasing Power Use

Rates and service charges are universal obstacles to extended service. Lower them and use will increase. Increase use, and charges can be lowered. Several means for lowering rural rates are possible with varying degrees of justification, including

1 Service at city rates, or on an area basis, all customers within the area being on the same base rate. Where farming sections are tributary to large cities or electricity-consuming centers, the farm rate may be materially lowered without imposing great burdens on the urban residents. As the rural consumption increases it will automatically carry its own costs. Indiana now has such an area-rate basis by legislative enactment. A number of private utilities are finding the stimulus to use justifies the change to area rates.

2 Subsidies such as government grants for line construction or other properties, tax exemptions, and low interest rates.

Any method of lowering rural rates is helpful in establishing or increasing the use of service. Some outside aid may be necessary at first. The *ultimate solution* of the rate problem, however, is increasing the use by developing farm applications for electricity which will pay for it and yield a profit.

Under present conditions in purely rural areas there seems to be a need for levying a service charge in some form to pay the added cost of rural-line construction and rural service. As the farm load develops, the need for this service charge will gradually decrease and disappear. There is some evidence even now that the elimination of the rural service charge in certain areas, accompanied by educational activities, will increase revenues sufficiently to offset the charge.

Rate forms are the packages in which electricity is sold. Some rural rates contain so many pages of provisions, complications, and options that only a trained rate engineer or specialist can understand the meaning of them. Other rural rates are so simple they may be printed completely in large type on a postal card. Both will produce approximately the same return per kilowatt-hour sold. One is a *safety rate,* the other a good-will rate. One breeds suspicion and distrust, the other understanding. One embodies all the many items of cost in proper sliding assemblies to protect the company from loss regardless of the quantity of electricity used by the consumer. The other enlists the confidence of the farmer through the use of understandable language.

Most present rural-distribution lines are urban lines transplanted in the country. They have resulted from precedent in urban practice rather than from fulfillment of an economic need of rural territory. Cost of line construction plays a much larger part in service costs in the country districts, where users are scattered, than it does in the city. Rural distribution costs are greater than the cost of generating the power distributed. They offer a likely place for research in rate reduction.

Some progress has been made by utilities in reducing line costs in recent years, mainly through longer spans between poles. The possibilities have not been exhausted. A return to farmer hauling and setting of poles might help.

Line-extension policies have been greatly improved in recent years. With an increased federal interest in rural service these policies may be further liberalized. The important thing is to consider extension assessments from the viewpoint of the farmer and his cash income, and endeavor to make their collection as light a burden as possible.

In regard to equipment and equipment costs, there are three opportunities for fostering rural service in the equipment field, namely, (1) lower costs, (2) better distribution, and (3) improved and new equipment which will produce a profit over costs of purchase and operation.

Electrical equipment has been notoriously high in price. That it can be reduced is being demonstrated by the Electric Home and Farm Authority in the Tennessee Valley. There are still plenty of opportunities in this direction.

Another problem in electric service to the farm is to make available reliable equipment at a price within reach of the farmer. This applies more particularly to farm appliances such as brooders, grinders, and equipment for other than house use. These sales and service outlets have not been adequately developed. Utility cooperation in sales seems to be essential. Household electric devices continue to be important in creating a desire for electric service in rural areas. By far the vast majority of farms having service use it for lighting, a radio, domestic appliances, and possibly an automatic water system.

Farm wiring should be both safe and adequate; safe because of the susceptibility of livestock to injury by stray currents and because of the inflammable nature of buildings in which the wires may be located; and adequate because there is almost a certainty of increasing use once service is installed. The cost of a safe and adequate wiring job done on union hours and wages and according to city standards is greater than any, except a few of the most prosperous farmers or city owners of farms, can afford to pay. The result is either no wiring, inadequate wiring, or makeshift wiring.

The development of a simplified system of lower-cost wiring for farms will be a step in the direction of bringing electric service within the reach of a new group of customers. It will make farm wiring safer by eliminating some of the unsafe extensions which are nailed up by the farmer himself because he does not have funds for a job engineered according to city standards.

If extensions of rural electric service are desirable either from the standpoint of improved standards of farm living or increased business for wiremen and manufacturers, then authorities responsible for making up wiring regulations, manufacturers, and contractors should give more attention to the liberalization of these regulations and sim-

plification of plans to fit farm needs. At present there are 5,330,000 unwired farms and a half million others only partly wired, and no one is getting the business.

Farm requirements differ somewhat from city requirements. Ninety-five per cent of the farm wiring is done in buildings now existing, while an almost equally large percentage of city wiring is done in new buildings. There is the possibility of developing less expensive yet safe methods of wiring suitable to farm conditions. There is also possibility of lowering the cost of wiring by furnishing to wiremen, particularly rural wiremen who are close enough to the job to understand farm economics, information concerning the most economical materials and methods that are now available.

Line construction, service leads, wiring, and equipment very often require financing when service is installed on a farm. All of these items are usually greater for farm service than for city service. Farm cash incomes are usually lower than city cash incomes. Financing in some form is usually necessary to rural electrification. The greatest need for financing is to care for line construction and equipment costs. Perhaps the least burdensome and surest method of repayment of such loans is through amortized installments attached to monthly power bills. Line-construction repayments may be further eased by substituting guaranteed minimum monthly or yearly revenues for immediate cash payments.

From the foregoing it can readily be seen that there is an unlimited field for research to develop lower costs of pole-line construction, house wiring, and appliances, better rate structures, and new practical uses of electricity. There is also need for creating a better understanding between the farmer and the utility. The USDA Bureau of Agricultural Engineering, in its studies of farm power and machinery and also of farm buildings and equipment, has of course been keenly aware of the great field of usefulness of electricity in agriculture and rural living as far as it can be made economically available. A prerequisite of wide general use of this convenient kind of power on farms is, as has been pointed out, an extensive program of research. The Bureau so far has not been able to enter extensively into this field, but plans to extend its activities as rapidly as it resources will permit.

The Challenge of Rural Electrification

(Continued from page 414) service on the farm offers power possibilities for bringing many operations back to the farm, which at one time were performed on the farm by hand but now have been taken over by factories. For example, there is the carding and weaving of wool, the making of clothes, the making of soap, etc. I do not believe that even the availability of electric service will bring back these operations, chiefly because it will be more economical to let the urban worker keep this task. Of far more importance to the farmer is the decentralization of industry which has been going on for years, thereby bringing the consuming public closer to the farmer's door. We can look for this movement to continue. Just how far it will go I do not know, but certainly conditions are such today that industrial operations can be located geographically and in such sized units as economic conditions justify. Some people go so far as to say that many industrial workers will ultimately live in the country; work at least part time in factories, and spend the rest of the time producing food. With the gradual decentralization of industry coupled with today's possibilities, including the automobile, good roads, and rural electric service, it would be logical for us to expect a swing toward rural living. Our industrial centers may ultimately be surrounded by workers living in the country, but this part-time industrialist and part-time farmer presents a picture which my imagination cannot visualize. Generally speaking, the individual wants either to be a farmer or an urban worker. True, there are some people today who have positions in town and who also farm. Undoubtedly there will always be some in this classification. However, I consider it wiser from an engineering viewpoint to work for a special system composed of farmers and industrial workers.

So we could go on. Here again is a subject worthy of much more extensive treatment. Suffice it to say we can expect an increase in rural population.

Looking at the situation in perspective, we find ourselves faced with the challenge of rebuilding rural America in keeping with modern possibilities. The engineer's objective is a society which makes available and uses an abundance of the necessities and luxuries which man demands and desires. Furthermore, this abundance would be produced with a minimum of labor. Make man a director of power rather than a prime mover. Give him leisure and ability to produce; time and means for recreation and travel. Put the motor to work. Free man from the bondage of drudgery. Build up our rural areas. Ours is an opportunity to fashion in accordance with 1934 possibilities. Just as truly as our ancestors who felled the trees, grubbed the stumps, and broke the prairies, pioneered a new nation, so are we, with far greater opportunities, pioneering a different society. This, as I see it, is the supreme challenge of rural electrification.

Terracing for the Idle Acres

THE SOIL is America's one permanent asset. It may be kept permanently productive, or by erosion be permanently lost. Appalling as soil loss may be under normal cropping, it is likely to be far worse under what could correctly be called a fallow condition. If we are to have a planned national economy, and reduction of tilled acreage is to be part of it, any subsidy on idle land should surely be conditioned on the permanent protection of that land—or other land on the same farm—from eternal destruction by erosion.

Cover crops have their helpful place, of course, but they are merely mitigants of the moment. If the American people are to invest millions or billions in the relief of agriculture, they should demand in return a guarantee of ample and reasonably cheap food for the generations to come. The only basic thing in that is physical preservation of the soil from washing to the sea.

As a class, agricultural engineers are the only men who know both the gravity of the problem and the methods of its solution. A few—too few—agricultural engineers already have urged on federal officials the wisdom of combining erosion control with any national plan for acreage reduction. They have pointed out that crop vacancy gives chance to get onto the land; that the idle acres imply spare man-power and availability of farm machinery which may be put to terracing.

Some Effects of Diameter on the Performance of Tractor Drivewheels[1]

By E. G. McKibben[2]

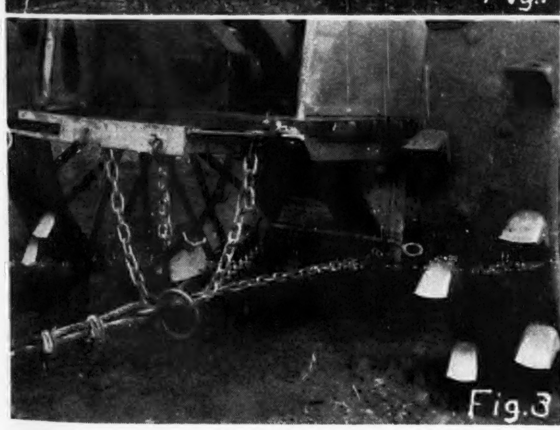
IN ORDER to obtain more complete information on the influence of diameter on the performance of tractor drivewheels, six sets of drivewheels of different diameters, 38, 42, 46, 50, 54, and 58 in were tried on three soil conditions during August 1934.

Wheels.[3] The wheels used are shown in Fig. 1 and described in Table 1. They were all equipped with 4-in spade lugs. As may be noted from Table 1, the lug spacing of the 42-in wheels and both the width and lug spacing of the 46-in wheels varied from that of the other wheels. While these variations were not great, there is some indication that they materially influenced the results (Figs. 8 and 10).

TABLE 1. TEST WHEEL CHARACTERISTICS

			Lugs		
Diameter, in.	Actual width, in	Tread, in	Number	Distance* between lugs, in	Distance** between lug rows, in
38	12⅛***	61	20	11.92	8.50
42	12⅛	53	22	11.94	9.00
46	11¼	53	24	12.04	7.25
50	12⅛	61	26	12.08	8.50
54	12⅛	61	28	12.12	8.50
58	12⅛	61	30	12.15	8.50

*Center to center of lugs in same row measured along rim.
**Center to center.
***Nominal width, 12 in.



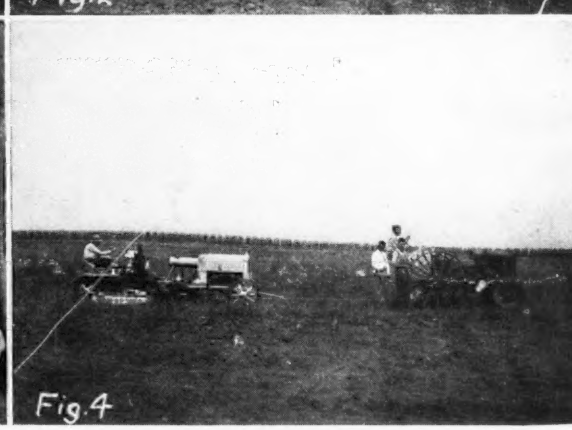


FIG. 1 THIS SHOWS THE 38, 42, 46, 50, 54, AND 58-IN WHEELS WITH 4-IN LUGS USED IN THE IOWA INVESTIGATION. FIG. 2 THE TEST TRACTOR WITH 38-IN WHEEL. "A" IOWA DYNAMOMETER USED TO MEASURE INPUT WORK. "B" AND "C," WEIGHTS ADDED TO KEEP TRACTOR WEIGHT CONSTANT. FIG. 3 SPECIAL DRAWBAR IN WHICH THE HITCH POINT WAS PLACED DIRECTLY BELOW REAR AXLE. FIG. 4 DYNAMOMETER CAR USED TO MAINTAIN A UNIFORM DRAWBAR LOAD

[1]Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December 1934. Journal Paper No. J198 of the Iowa Agricultural Experiment Station. Project No. 403.

[2]Associate professor of agricultural engineering, Iowa State College. Mem. A.S.A.E.

[3]In this connection the author wishes to acknowledge the cooperation of French and Hecht, Inc., who built to order four sets of the wheels, and of the following tractor manufacturers who furnished items of wheel and lug equipment: John Deere Tractor Co., International Harvester Co., and the Oliver Farm Equipment Co.

[4]Collins, E. V., Efficiency Tests of Tractor Wheels and Tracks, Agricultural Engineering (1933), vol. 14, no. 2, pages 35-38.

[5]Studies in the Physical Properties of Soils, Journal of Agricultural Science, vol. XII, part II, April 1925.

Test Tractor. The test tractor is shown in Fig. 2. This had a rebuilt transmission which made possible the measurement of the work input to the drivewheels[4]. When using the smaller wheels, weights were added both front and rear, as needed to keep the weight supported by the front wheels and rear wheels constant for each set of trials. The total weight of the tractor as used during trials was 5620 lb, including the operator. When standing on level ground without drawbar load, the weight on the front wheels was 1730 lb and on the rear wheels 3890 lb.

Drawbars. Special drawbars were built for this investigation. They were so designed that the hitch point would be directly below the rear axle and the same distance (9 in) above the wheel rim for all wheels (Fig. 3). Thus, soil surface irregularities, rising of the front wheels, digging in of the rear wheels, etc., had a minimum influence upon the effective drawbar height.

Dynamometers. The input to the drivewheels was measured by an Iowa dynamometer (Fig. 2) used in connection with the special transmission mentioned above. The output was measured by the constant-load dynamometer car[4] shown in Fig. 4.

Test Fields. Complete sets of trials with all six sets of wheels were made on three soil conditions: (1) Pulverated (plowed with a Pulverator Plow) oat stubble, (2) oat stubble without tillage treatment, and (3) bluegrass sod. The soil texture was loam to silty clay loam. The water content of the soil, calculated on the dry basis, varied from 11.3 to 17.2 per cent for the pulverated soil, from 10.3 to 24.6 per cent for the oat stubble, and from 4.1 to 5.9 per cent for the bluegrass sod.

The wide variation in water content for the pulverated soil and oat stubble was the result of a 0.45-in rain on Wednesday preceding trials on Friday afternoon, Saturday, Monday, and Tuesday forenoon. Since the soil had been very dry and the weather was very hot, soil moisture resulting from this rain disappeared very rapidly, causing a marked change in per cent of soil water content before the trials could be completed. The effect of this variation can be seen in Figs. 8, 9, and 10. The curves obtained for the 38, 50, and 58-in wheels tried on Friday and Saturday, August 17 and 18, differ definitely from those for the 42, 46, and 54-in wheels tried on Monday and Tuesday, August 20 and 21.

Fig. 5 is further evidence of the effect of even small variations in soil condition on the performance of drivewheels.

Performance Factors. The following performance factors were investigated: (1) No-load rolling diameter, (2) travel ratio, (3) force ratio, (4) overall work efficiency, (5) maximum drawbar pull, (6) drawbar pull for best efficiency, (7) rolling resistance, (8) turning radius, (9)

TABLE 2. COMPARATIVE TRACTIVE PERFORMANCE OF WHEELS

1	Wheel diameter, in	38	42	46	50	54	58
2	Maximum load,** pulverated soil, lb	1550	1700	1625	2000	2100*	2200*
3	Increase*** in maximum load, %	00.0	9.7	4.8	29.0	35.5	41.9
4	Load** for maximum efficiency, pulverated soil, lb	700	850	900	1000	950	1200
5	Increase*** in load for maximum efficiency, pulverated soil, %	00.0	21.4	28.6	42.8	35.7	71.4
6	Load** for maximum efficiency, stubble, lb	2400	2300	2400	2400	2300	2500
7	Maximum** efficiency, pulverated soil,%	28.5	32.0	36.0	37.0	40.5	40.0
8	Increase*** in performance, pulverated soil, %	00.0	12.3	26.3	29.8	42.1	40.4
9	Maximum** efficiency, stubble,%	59.0	59.0	60.0	63.0	65.5	69.0
10	Increase*** in performance stubble, %	00.0	00.0	1.7	6.8	11.0	16.9

*Largely an estimate; engine did not have enough torque to slip the 54 and 58 in wheels.

**Taken from the curves of Figs. 8 and 10 rather than the highest individual results.

***Based on performance of 38-in wheels.

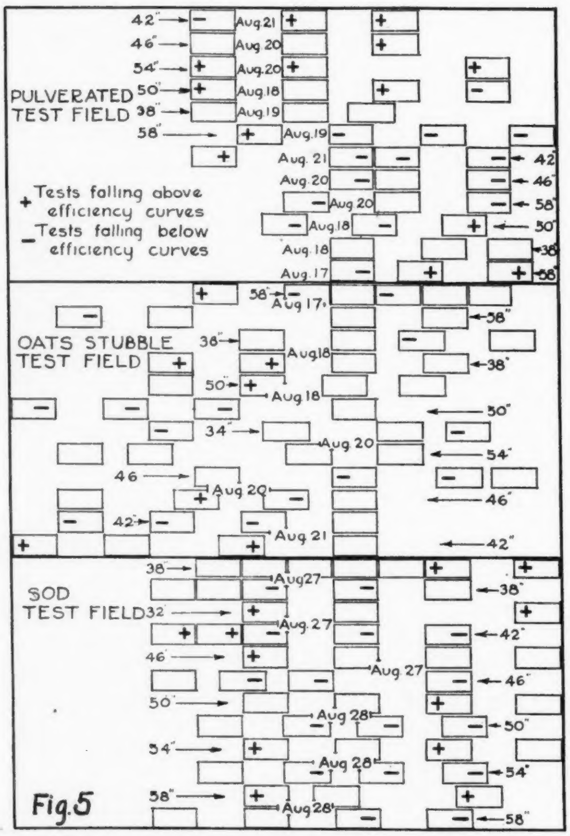


FIG. 5 RELATIVE LOCATION OF TRIALS ON TEST FIELDS. NOTE THE TENDENCY FOR TRIALS TO BE GROUPED, WHERE EFFICIENCIES ARE ABOVE OR BELOW THE AVERAGE

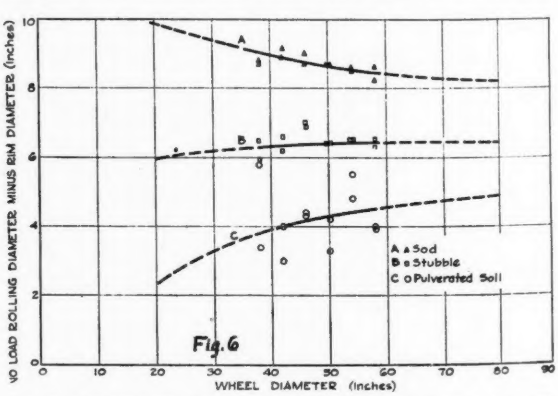
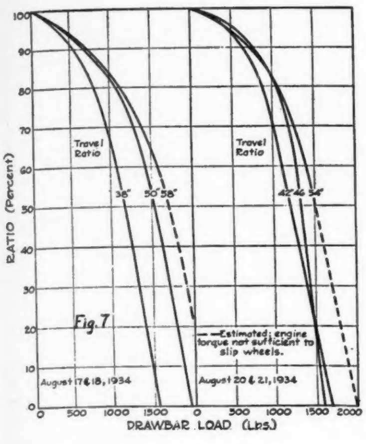
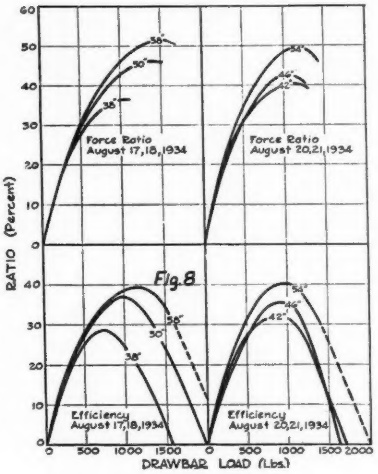
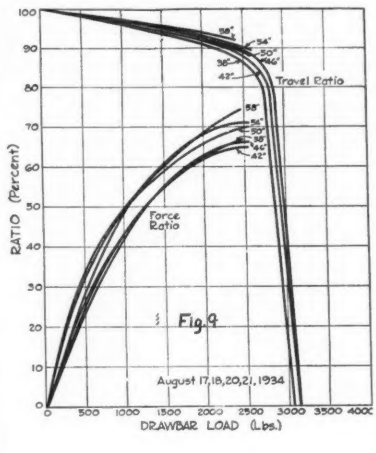
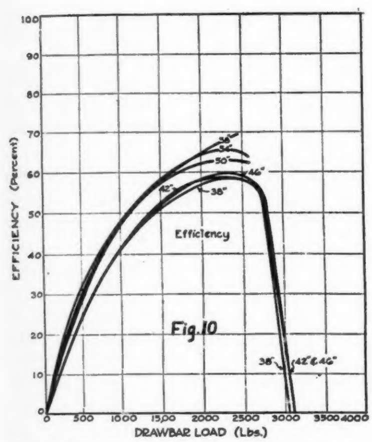


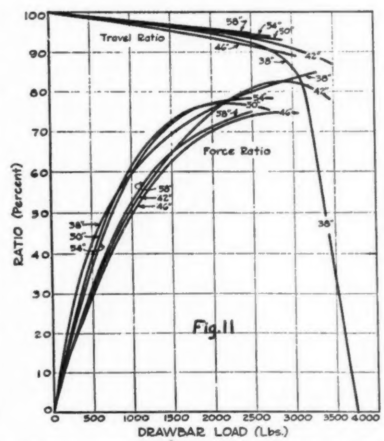
FIG. 6 INCREASE OF NO-LOAD ROLLING DIAMETER OVER RIM DIAMETER FOR DIFFERENT WHEEL SIZES ON THREE SOIL CONDITIONS. ALL WHEELS EQUIPPED WITH 4-IN SPADE LUGS











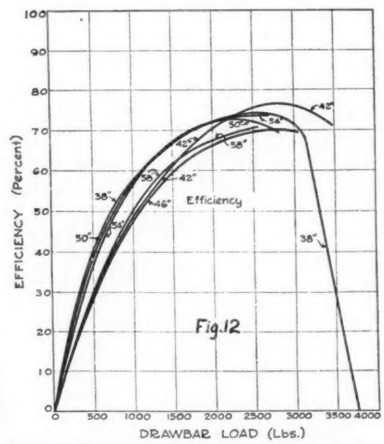


FIG. 7 TRAVEL RATIO ON PULVERATED OAT STUBBLE. THE TRAVEL RATIO WAS OBTAINED BY DIVIDING THE DISTANCE TRAVELED BY ONE REVOLUTION DURING TRIAL BY THE DISTANCE TRAVELED BY REVOLUTION WITHOUT LOAD. SOIL MOISTURE CALCULATED ON DRY BASIS WAS 4.5 PER CENT HIGHER DURING TRIALS OF 38, 50, AND 58-IN WHEELS. FIG. 8 FORCE RATIO AND EFFICIENCY OF WHEELS ON PULVERATED OAT STUBBLE. FORCE RATIO WAS OBTAINED BY DIVIDING THE DRAWBAR PULL BY THE INPUT FORCE, CALCULATED ON THE BASIS OF THE NO LOAD ROLLING RADIUS (SEE FIG. 5). EFFICIENCY WAS OBTAINED BY MULTIPLYING FORCE RATIO OF THIS FIGURE BY THE TRAVEL RATIO OF FIG. 6, AND REPRESENTS OVERALL WORK EFFICIENCY. FIG. 9 PERFORMANCE OF WHEELS ON OAT STUBBLE. (SEE FIGS. 6 AND 7 FOR DEFINITION OF TRAVEL AND FORCE RATIOS.) FIG. 10 OVERALL WORK EFFICIENCY OF WHEELS ON OAT STUBBLE. FIG. 11 PERFORMANCE OF WHEELS ON BLUEGRASS SOD. (SEE FIGS. 6 AND 7 FOR DEFINITIONS OF TRAVEL AND FORCE RATIOS.) THIS FIELD WAS VERY DRY AND NOT VERY UNIFORM. THE DIFFERENCES IN SOIL CONDITIONS WERE MORE IMPORTANT THAN THE DIFFERENCES IN WHEEL DIAMETERS. FIG. 12 OVERALL WORK EFFICIENCY OF WHEELS ON BLUEGRASS SOD. (SEE EXPLANATION ON FIGS. 10 AND 11.)

tangential force required to go over obstructions, and (10) stability when going over obstructions.

No-Load Rolling Diameter. As used in this paper, this means the distance traveled by the tractor, without drawbar load, during one revolution of the drivewheel divided by 3.1416. The results are given in Fig. 6.

Travel Ratio. This ratio was obtained by dividing the distance travelled during one revolution of the drivewheel for the given trial by the distance travelled during one revolution, without load, on a similar soil surface. The results are shown in Figs. 7, 9, and 11. Each of the curves for a given set of wheels on a given soil surface represents six to twelve trials.

Force Ratio. This ratio was obtained by dividing the drawbar pull, corrected for grade, by the input force at the end of a radius equal to one-half the no-load rolling diameter. The results are shown in Figs. 8, 9 and 11. Each curve represents six to twelve 50-ft trials.

Efficiency. This was obtained as the product of travel ratio by force ratio and represents overall work efficiency. The results are shown in Figs. 8, 10, and 12. Each curve represents six to twelve 50-ft trials.

Maximum Drawbar Pull. In so far as the engine torque was sufficient, the maximum drawbar pull for each set of wheels on each soil condition was obtained by gradually increasing the load until forward motion was stopped. The results are shown in Figs. 7, 9, 11, and 13, and in Table 2.

Drawbar Pull for Maximum Efficiency. The drawbar pull for maximum efficiency, as taken from the curves of Figs. 8 and 10 rather than from the highest individual trial results, is shown in Fig. 13 and Table 2.

Rolling Resistance. The rolling resistance of the different set of wheels on pulverated soil and oat stubble was obtained by use of an Iowa dynamometer and another tractor, the wheels of which did not track with those of the test tractor. The results are shown in Fig. 14.

Turning Radius. Fig. 15 shows the no-load turning radius of the center of the rear axle as affected by wheel

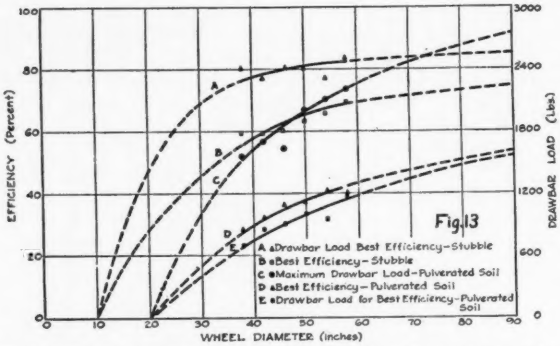


FIG. 13 THE BROKEN LINES IN THESE CURVES ARE AT BEST ONLY AN ESTIMATE; HOWEVER, THEY INDICATE THE NEED OF INVESTIGATING AT LEAST ONE SMALLER AND PROBABLY ONE LARGER SET OF WHEELS

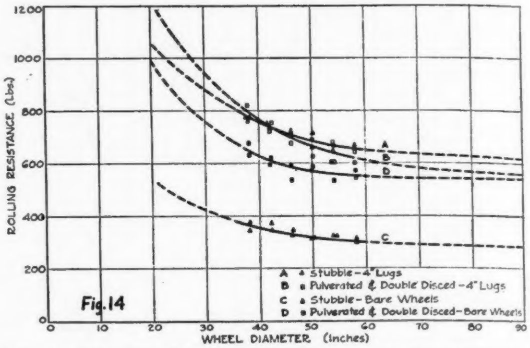


FIG. 14 ROLLING RESISTANCE OF TRACTOR ON OAT STUBBLE AND PULVERATED AND DOUBLE-DISKED OAT STUBBLE AS AFFECTED BY REAR WHEEL DIAMETER AND LUGS. WEIGHT ON REAR WHEELS WAS 3890 LB AND ON FRONT WHEELS 1730 LB FOR ALL TRIALS. FRONT WHEELS WERE 7.5x18-IN PNEUMATIC TIRES OPERATED AT A PRESSURE OF 20 LB PER SQUARE INCH

diameter. The position of the front wheels with respect to the tractor frame was the same for all trials. However, the changing of the rear wheel diameter changed the wheel base and the angle of the steering spindles, resulting in a changing theoretical turning radius as shown.

Broken Lines of Graphs. The broken lines of Figs. 6, 13, 14, and 15 are at best only an estimate and probably little better than a guess. However, they serve to indicate very definitely the need of trials of a wider range of wheel sizes. For example, the inclusion of a 20 to 30-in and a 70 to 80-in set of wheels would have given a very much more complete picture of the influence of wheel diameter.

Tangential Force Required to Go Over Obstructions. The effect of drivewheel diameter on this performance factor as calculated by static theory is shown in Fig. 16. At higher speeds the tangential force required to maintain a constant forward speed would be increased; however, under such conditions the advantages of the larger drivewheels would be still greater.

Stability Going Over Obstructions. The effect of drivewheel diameter on stability when passing over obstructions on level ground with an unloaded tractor are shown in Fig. 17. These results are also calculated on static theory, as under most situations this represents the condition of greatest handicap for the large drivewheel. Because it is impossible to go over an obstruction without some speed, and since the moment of inertia of the front wheels and frame about the rear axle is usually greater than that of the entire tractor about the lug point in contact with the obstruction, it is usually possible to go over a somewhat larger obstruction than Fig. 17 would indicate. This is checked by the broken line of Fig. 17 which shows the results of laboratory trials with the test tractor for which d was equal to 20 in.

SUMMARY

1 On the less firm soil conditions there was a very important variation in performance of the wheels investigated.

2 There was definite indication of the effect of the water content of the soil on wheel performance (See Figs. 7 and 8). The average water content was 4.5 per cent (calculated on the dry basis) higher during tests made on August 17 and 18. The per cent of soil moisture for maximum traction was apparently higher than that for highest efficiency.

3 There was further evidence of the effect of even small variations of soil condition on the performance of wheels (See Fig. 5). Apparently the soil is the most difficult variable to control when making traction trials and should be given more attention. This checks with results reported by W. B. Haines of the Rothamsted Research Institute.[5]

4 The effective no-load rolling diameter (obtained by dividing the distance traveled during one revolution by 3.1416) increased as the firmness of the soil increased (See Fig. 6).

5 The increase of effective no-load rolling diameter over rim diameter was greater for the smaller wheels on firm soil and for the larger wheels on the loose soil (See Fig. 6).

6 There was marked improvement in performance from the smallest (38-in) to the largest (58-in) wheels on the pulverated soil (See Figs. 7 and 8). The maximum drawbar pull was increased from 1550 to 2200 lb, or 41.9 per cent; the drawbar pull for maximum efficiency was increased from 700 to 1200 lb, or 71.4 per cent, and the best efficiency was increased from 28.5 to 40 which is a performance gain of 40.4 per cent (See Fig. 13 and Table 2).

7 There was also improvement in performance from the smallest to the largest wheels on oat stubble (See Figs. 9 and 10). This was particularly true of the overall efficiency which was increased from 59 to 69 per cent, a performance increase of 16.9 per cent (See Fig. 13 and Table 2). There was not sufficient engine torque to determine maximum drawbar pulls for the 50, 54, and 58-in wheels.

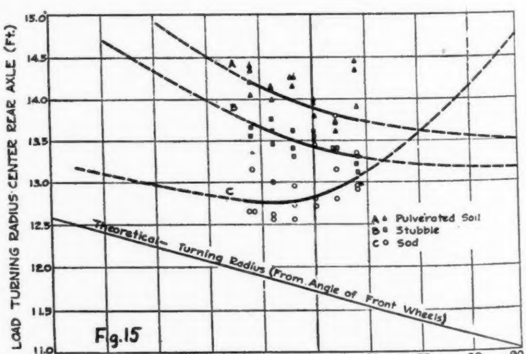
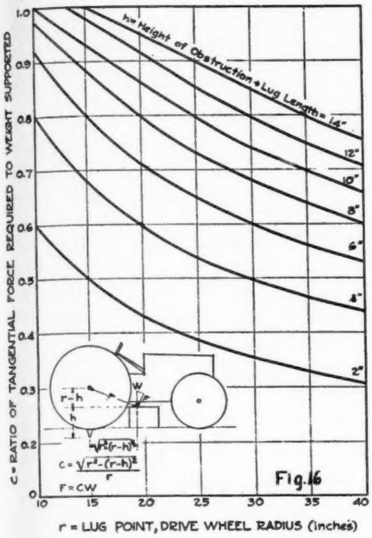


FIG. 15 EFFECT OF DRIVEWHEEL DIAMETER ON NO-LOAD TURNING RADIUS. POSITION OF FRONT WHEELS WITH RESPECT TO TRACTOR FRAME WAS THE SAME FOR ALL TRIALS. HOWEVER, THE CHANGING OF REAR WHEEL DIAMETER CHANGED THE WHEEL BASE AND THE ANGLE OF STEERING SPINDLES, RESULTING IN A CHANGING THEORETICAL TURNING RADIUS AS SHOWN



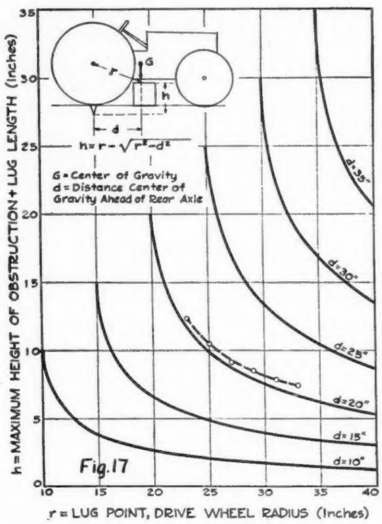


FIG. 16 EFFECT OF DRIVEWHEEL RADIUS (TO LUG POINT) ON THE TANGENTIAL FORCE REQUIRED TO GO OVER OBSTRUCTIONS

FIG. 17 EFFECT (CALCULATED BY STATIC THEORY) OF DRIVEWHEEL DIAMETER (TO LUG POINT) ON STABILITY WHEN PASSING OVER OBSTRUCTIONS FOR TRACTORS WITH VARIOUS LOCATIONS OF CENTER OF GRAVITY. BROKEN LINE INDICATES RESULT OF LABORATORY TRIALS WHERE d WAS EQUAL TO 20 IN

There was only a slight increase in the drawbar pull for best efficiency.

8 On the relatively firm sod the differences in soil conditions (this was an unsatisfactory test field) were more important than the variations in wheel diameter (See Figs. 10 and 11).

9 There was some indication of poorer performance of the 46-in wheels, which were 7/8 in narrower and had the lug rows spaced 3/4 in closer, and of slightly better performance of the 42-in wheels which had the lug rows spaced 1/2 in wider. This seems to indicate the desirability of placing lugs as far apart as possible (See Figs. 8 and 10).

10 The picture of the effect of wheel diameter on performance would have been much more complete if a 20 to 30-in and a 70 to 80-in wheel could have been included (See Figs. 6, 13, and 14); however, this would have involved the development of considerable additional test equipment.

11 The difference in rolling resistance between the smallest (38-in) and the largest (58-in) wheels on loose soil was 95 lb for the bare wheels and 164 lb when equipped with 4-in lugs, and on oat stubble 53-lb for the bare wheels and 113 lb when equipped with 4-in lugs (See Fig. 14).

12 Adding 4-in lugs increased the rolling resistance of the 38-in wheels 134 lb on loose ground and 416 lb on oat stubble, and the 58-in wheels 61 lb on loose ground and 356 lb on oat stubble (See Fig. 14).

13 There is no indication of materially increased resistance to turning except on sod. Even there the increase did not appear to be serious (See Fig. 15).

14 The larger wheels have an advantage from the standpoint of the decreased tangential input force required to go over a given obstruction (See Fig. 16).

15 The larger the wheels, the smaller the obstruction which can be passed over without destroying the stability of the tractor (See Fig. 17).

16 In order to give a more complete picture of the influence of drivewheel diameter, the relationship to lug length and rim width should be investigated further.

17 Further study, using the methods of mathematics and analytical mechanics, should be made of this and other similar data to determine if possible the fundamental laws governing the influence of drivewheel diameter on performance.

Contour Farming Aids Soil Erosion Control

AT THE ALABAMA Agricultural Experiment Station, M. L. Nichols found that, when the rows were on the contour there was a very small loss of soil from cultivated fields on slopes up to ten per cent, while the soil loss, when the rows were with the slope, increased from a negligible amount to about 1500 lb per acre for a one-inch rain in 8½ min. The soil losses resulting from our common practices of cultivation are two times or more greater than the losses resulting from contour farming. In every case the contoured rows produced greater yields than rows running with the slope. Nichols' experiments indicate very clearly that slopes above 10 to 12 per cent should not be cultivated in the usual manner, if we are going to maintain our soil fertility.

In places where it is necessary to farm part of the steep slopes in cultivated crops, strip farming should be employed—that is, strips of sod are alternated with strips of cultivated crops, the strips running along the contour of the land. The strips of cultivated land can range in width from 50 to 100 ft depending upon the steepness of the slope. The run-off from the cultivated land will be retarded when it goes through the sod strips and will drop its silt load in the grass instead of carrying it on to the streams.

In most cases the slope of the land will be uneven enough to make it necessary to have point rows, that is, rows that do not run to the end of the field; but if all these point rows are run parallel to either the upper or lower series of long rows they cause very little difficulty. When planting or cultivating, turns should always be made from the longer to the next shorter row.

Strip and contour farming takes a little more time than ordinary farming, but the big saving in soil fertility makes the total cost in favor of the first method. After the contour and strips have once been established, there is no upkeep cost. It is very important to have the strips laid out exactly on the contour, otherwise they will not be effective.

Paints and Finishes for Farm Structures[1]

By John W. Iliff[2]

PAINT is a material which is liquid in the can. After application it dries and forms a thin film which becomes comparatively hard. On aging it gradually becomes still harder and more brittle. It also becomes chalky, and it eventually fails. There is no such thing as a permanent paint, although there are decided differences between the degrees of available durability in different types of paint. From the viewpoint of the consumer, paint has a useful life and the value of the paint to the consumer is dependent upon the length of this life or the period of time until repainting is necessary in order to maintain the structure.

From the standpoint of the manufacturer of paint, it is desirable to divide this practical life into different classes of failure. The first of these is a straight breakdown of the film itself and this is due to weathering. This is affected by (1) the composition of the paint; (2) the surface to which it is applied; and (3) the location in which the surface is exposed. There is a second type of failure which might be called abnormal although it occurs frequently enough: It is due to the loss of adhesion of the film to the surface to which it, or previous coats of paint, have been applied. This failure frequently occurs before the film itself has broken down at all. In this paper I am going to discuss these two types of failure. There is a third type which will not be discussed here, and that is the change in appearance which may or may not be related to the ultimate breakdown of the film; the colors will fade, paint will collect dirt, etc. This paper, however, will be confined solely to the failure as it affects the maintenance of the surface to which it is applied.

From the viewpoint of painting, farm structures do not differ greatly from other structures which are to be maintained by painting except in the proportion of the different types of paintable surfaces. Paintable exterior surfaces on farm structures may be broadly divided into three classes: (1) That of wood; (2) that of metal; and (3) other surfaces. The greatest area which may be painted on the average farm structure is that of wood, and for this reason most of this paper will be devoted to the painting of wood.

I am not going to attempt to discuss the relative merits of the different arguments which have been put forth from time to time during the past few years regarding the economic value of the painting of wooden farm structures. I think it is sufficient to say that, if one wishes to maintain a wooden structure in approximately its original condition, painting is necessary practically from the start. An unpainted structure made of wood will warp and wood check. Warped wood means air leaks and the breakdown of the surface due to wood checking, etc., will soon leave an area which is extremely difficult to paint. It is highly absorbent, it is rough and will take a great deal of paint to get a fairly satisfactory job.

Of course, paint adds to the appearance of buildings and it prevents the type of disintegration mentioned.

In many respects the painting of wood is more difficult than the painting of metal or masonry surfaces. Wood is a porous, non-homogeneous, and decidedly variable material. On this account it has always offered a considerable problem to the painter. The painting of wood, therefore, is one of the most interesting, although it offers the most difficult of the problems involved in the painting of farm structures. I am going to cover, first, the differences in wood species and their effect on practical paint durability; second, the effect of different climates on paint durability; and third, factors which produce unexpected or unusual types of failure on wood.

There is a marked difference in the paint-retaining characteristics between different species of wood. The USDA Forest Products Laboratory at Madison, Wisconsin, was the first to definitely establish the relationship between the paint-retaining characteristics of different species of wood. For example, red cedar and white pine have good paint-retaining characteristics and southern yellow pine and Douglas fir have poor paint retaining characteristics. The Laboratory also established the paint-retaining characteristics of other species of wood which may also be involved from the standpoint of external painting characteristics.

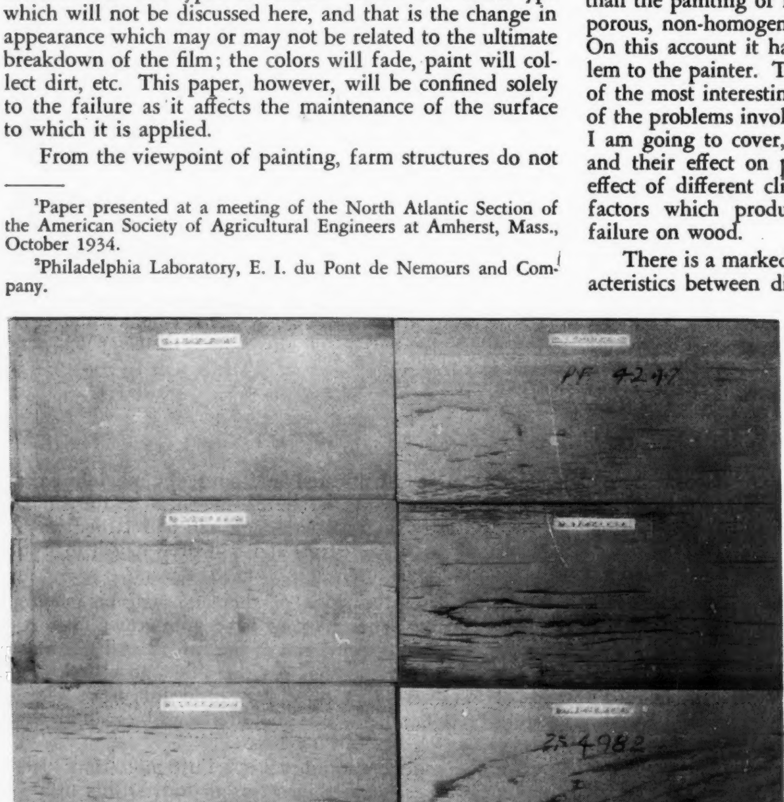


FIG. 1 THIS ILLUSTRATION SHOWS THE STANDARDS USED IN THE DU PONT LABORATORIES FOR REPRESENTING THE DIFFERENT DEGREES OF FAILURE OR RATING FOR PAINTS ON WOOD SURFACES

[1]Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers at Amherst, Mass., October 1934.

[2]Philadelphia Laboratory, E. I. du Pont de Nemours and Company.

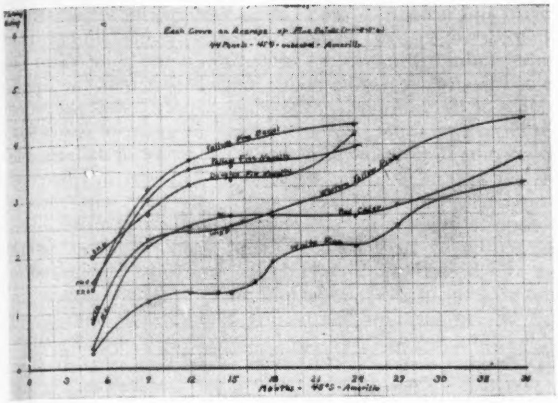


FIG. 2 THESE CURVES SHOW THE PAINT-RETAINING CHARACTERISTICS OF DIFFERENT SPECIES OF WOODS

As I have already stated, wood is a decidedly variable material. For example, if you will examine a piece of yellow pine you will note that the wood itself is divided into two distinct areas; the first is a hard dense wood, and the second is a soft wood. The dense wood is summer growth and differs from the soft or spring growth in that it possesses very much thicker cell walls. You will note that you cannot dent the dense summer wood with the fingernail except with difficulty while the soft wood is easily dented. Douglas fir also possesses about the same characteristics. In contrast to this if you will examine a piece of northern white pine, you will note that the summer wood, although easily distinguished, is not nearly as hard as the summer wood of yellow pine and Douglas fir. Redwood and red cedar are also similar. Both of these woods are light and have light summer wood growths.

When paint is applied to southern yellow pine and Douglas fir, it has a comparatively short life, and this is due to the fact that the paint after a considerable period of exposure will simply not adhere to the dense summer growth as well as it does to the lighter wood of the spring growth, or to the other species such as white pine, redwood, and red cedar.

In Fig. 1 is shown the type of failure which is obtained over these woods of poor paint-retaining characteristics.

I wish to emphasize here, however, that, in speaking of good woods or poor woods from the paint-retaining standpoint, I refer only to the paint-retaining characteristics of these woods. Many of these woods such as southern yellow pine and Douglas fir are particularly good from the structural standpoint; in fact, they are stronger than white pine and red cedar which in turn are better from the paint-retaining standpoint.

The laboratories of our company have also done a considerable amount of work with wood types versus paint failure, and a few of these results should be of interest. Before showing you these results, however, I wish to digress for a moment in order to define the types of failure which are included in the curves which illustrate some of these points.

From the standpoint of the maintenance of the surface to which paint is applied, the proportion of bare wood exposed by the failing paint, at any one time, may be used as representative of a certain degree of failure. We have, therefore, arbitrarily assigned numerical ratings to the different degrees of failure which are used here. In Fig. 1 the standards which we use as representing these different degrees of failure or rating are shown. A flaking rating of "0" means no flaking failure whatsoever, and as flaking increases the rating is increased to a maximum numerical value of "6", which it will be observed is a very advanced degree of failure. Properly speaking all structures ought to be repainted prior to or at least by the time the paint has reached the degree of failure represented by Flaking Rating No. 3.

The differences between the paint-retaining characteristics of different species of wood are illustrated in Fig. 2. This chart shows the life history of several paint compositions exposed at our Amarillo, Texas, test farm. It will be observed that the red cedar and the white pine are distinctly better during failure than the yellow pine and Douglas fir, from the standpoint of paint-retaining characteristics. Western yellow pine or ponderosa pine follows an intermediate course. This, on the whole, checks the results published by the Forest Products Laboratory.

From the standpoint of the user of paint, it is unfortunate that these woods, which are difficult from the paint-retaining standpoint, are increasing in the proportion available for use. Moreover, the better woods are being used less and less, partially because much of the supply has been exhausted. In the southern part of the United States, yellow pine is used almost exclusively, and yellow pine has found its way well into the southwest states such as Oklahoma and Texas. This wood is largely grown in the South, which accounts for its distribution there. Douglas fir is produced on the Pacific Coast, and low ocean freight rates have permitted it to penetrate into all areas which are available from the Coast within freight distances not very much shorter than the distances from the northern forests. Red cedar is also produced on the Pacific Coast, and it might also have a similar distribution. However, red cedar is more costly than Douglas fir. The northern white pine is decreasing in available quantity and in areas where it may be purchased. This geographical misdistribution of wood is carried out to such an extent that in certain parts of the United States the good woods, from the paint-retaining standpoint, cannot be purchased at any price without special importation.

As the paint durability is affected by the surface to which it is applied, it is also affected by the climate to which it is exposed. In southern Florida, for example, is found intense sunlight, but the temperature varies little in comparison to other parts of the country. It does not get excessively hot, and it seldom freezes. Moreover, the relative humidity does not get excessively high, except during a rainstorm, and it seldom ever gets low. Consequently, Miami may be said to have a uniform climate. In contrast to Miami, many parts of the United States, such as the panhandle of Texas, have a climate in which temperatures and humidities fluctuate quickly and widely. Our company realized the decided effect of climate, and it has maintained for some time major test farms in three different locations. These locations are Miami, Florida; Amarillo, Texas, and near Wilmington, Delaware. Other small test farms are also maintained in other parts of the country.

The differences in climate between Miami and Amarillo and Philadelphia (Wilmington) are shown in the two charts which were prepared from the figures of the U. S. Weather Bureau. The first of these charts, Fig. 3, shows the maximum temperature variation for each month in Miami, Philadelphia, and Amarillo for the year following the exposure of the panels which are being discussed, and in Fig. 4 the corresponding humidities are shown. The wide fluctuations of temperature and humidity at Amarillo in comparison with Miami are evident, while Philadelphia occupies an intermediate position.

Wood like other materials expands and contracts with

changes in temperature. Moreover, it expands greatly as it takes up moisture. Therefore, one would expect that the comparatively violent changes in temperature and humidity at Amarillo would result in comparatively great and quick changes in the dimensions of the wood. A paint also expands and contracts with variations in temperature and humidity but to an entirely different extent than wood. Due to the close relationship between the paint and the surface to which it is applied, one might, therefore, expect that the relatively wider fluctuations in Amarillo would cause the paint to fail sooner than it would in Miami. On the other hand, Miami has the stronger sunlight or higher proportion of actinic rays in comparison with the other test locations, this being due to its subtropical location. The destructive effect of sunlight is therefore accentuated in Miami. Fig. 5 shows the average life history of four different paints exposed at the three test locations. It will be observed that Paint No. 1 is the best at Amarillo and the poorest at Miami, and that Paint No. 4 which is decidedly the best at Miami is about the worst at Amarillo, while the exposure at Wilmington, Del., shows intermediate results. It happens that Paint No. 4 is a hard and comparatively brittle paint, and, as one might expect, it has given a poor account of itself under widely fluctuating climatic conditions of Amarillo. On the other hand, it also happens to be the paint which is the most resistant to intense sunlight, and in view of the comparatively mild fluctuations in temperature and humidity of Miami and its good resistance to sunlight, it has shown decidedly the best results in that location.

The failure which takes place on summer wood is generally that of the breaking off of small pieces. It is related to a breakdown of the film itself. We call this "flaking", and as you have observed in Fig. 1, this follows the summer grain and it occurs after a considerable period of exposure. In contrast to this we find another type of failure. This other failure is due to the separation of the paint from the wood, and it frequently occurs much earlier than the breakdown of the film itself. The paint simply leaves the wood in large pieces and does not follow the grain of the wood. Blistering is often the first sign of this type of failure, and it may appear in a new paint film. Later on this may develop into peeling. Sometimes peeling may start without the blistering having been observed in the first place. This separation of large areas of paint from the wood, which we call blistering and peeling, is almost invariably due to the presence of moisture behind the film. This moisture can get behind the film because the wood, as we have stated above, is a porous material. It may come from leaky flashing or other external leaks which permit rain water to drive down behind the film. It also might come from internal high humidity which causes condensation on the inside of the cold external siding. When you have peeling of paint from wood, it may be the fault of the paint, but if the paint was purchased from a reputable manufacturer, the probabilities are strong that you have a structural defect in your building and that the paint itself is not responsible.

There is another type of peeling or separation of comparatively large pieces of paint which you undoubtedly have observed, particularly during this last cold winter. This is peeling from galvanized iron surfaces. Galvanized iron represents a very considerable proportion of the area around many farms. If the galvanized iron is not painted, it will eventually rust because the zinc coating is not permanent. Therefore, if it is to be maintained in its original condition, painting is necessary. The adhesion of paint to galvanized iron has always been a serious problem for the paint manufacturer. Ordinary paint simply will not adhere to galvanized iron as well as it does to steel, and efforts have been made on the part of paint manufacturers to produce

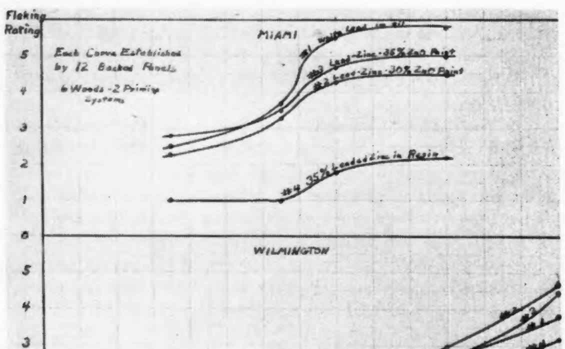


FIG. 3 THIS CHART SHOWS THE MAXIMUM TEMPERATURE VARIATION FOR EACH MONTH IN MIAMI, PHILADELPHIA, AND AMARILLO FOR THE YEAR FOLLOWING THE EXPOSURE OF THE TEST PANELS

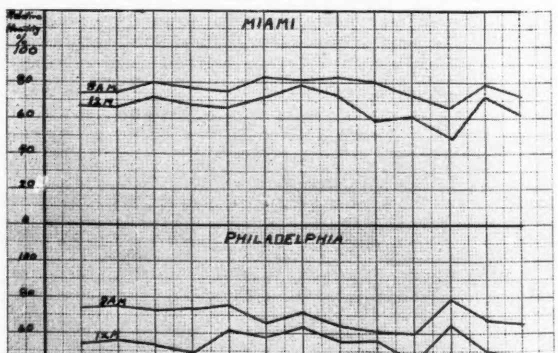


FIG. 4 THE FLUCTUATION IN HUMIDITY CORRESPONDING TO THE TEMPERATURE VARIATIONS SHOWN IN FIG. 3

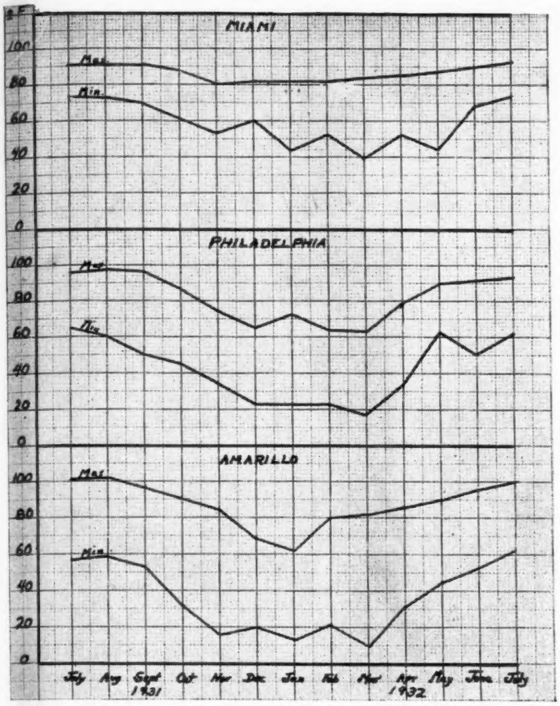


FIG. 5 THE CURVES SHOW THE AVERAGE LIFE HISTORY OF FOUR DIFFERENT PAINTS EXPOSED AT THREE DU PONT TEST LOCATIONS

a primer for galvanized iron which will adhere satisfactorily; some improvement has been made along this line.

The reason for this poor adhesion to galvanized iron is not accurately known, but we suspect that there may be a reaction between the vehicle and the zinc which destroys adhesion. This theory is strengthened by the fact that the initial adhesion of paint to galvanized iron is generally better than it is later, and on continued exposure peeling may ultimately occur. Some day the paint industry may develop and sell a primer which will always adhere to galvanized iron. At present, however, one cannot be sure of uniformly good results. Nevertheless, if galvanized iron is not maintained by painting, rusting will start, and it is more difficult to handle a rusty area than the same area prior to the appearance of rust. If the rusty area is not treated at once, however, rapid corrosion of the iron will take place.

The necessity for painting iron and steel requires no argument. It has been well established that iron and steel will corrode rapidly if exposed to the weather, and the necessity for maintaining iron and steel surfaces with a good paint system goes almost without argument. In the painting of steel it is highly desirable, as in the case of wood, to take care of it at once when it is new, otherwise a heavy coating of rust offers an irregular and absorbent surface which makes the maintenance of subsequent paint much more difficult. When rust appears on a galvanized iron area it should be carefully scraped off, preferably a good metal protective primer applied to the bare steel surface and then the whole surface should be painted over with the desired finish coat system which should include a good galvanized iron primer.

There are, of course, other types of surfaces than wood, galvanized iron, and steel which are present on farm structures, but time limitations will not permit a discussion of these comparatively minor areas. I will, however, be glad to attempt to answer any questions concerning them.

In conclusion, I would like to point out first that in painting wood one is dealing with a variable, porous, and non-homogeneous surface. It is a surface which also gives different results in different localities, but that if it is to be maintained in its original condition, an adequate painting program must be carried out. When one is paying for a paint job, one pays not only for the paint but also for the labor and the cost of the labor generally exceeds the cost of the paint. Therefore, the use of a high-grade paint is the most economical in the end because in order to keep costs down, one must repaint as infrequently as possible. On the other hand, repainting should be carried out before an advanced degree of failure has taken place. During the depression there has been a great tendency to neglect painting, and there are many surfaces which should have been painted some years ago and which will probably be repainted soon if the area is to be reclaimed. I wish to emphasize, however, that on account of the neglect which has taken place, one cannot logically expect as good results as if the painting had been done before the areas had gone to pieces to such an extent that the new paint has a poor foothold through to the wood. The same thing, of course, applies to other surfaces. A neglected steel surface will show bad rusting and a comparatively expensive cleaning job is necessary before repainting. The use of good paint applied at sufficiently frequent intervals will be the cheapest over a period of years.

Soil Protection

THOUGH they know it not, the soil erosion problem is of more concern to the urban masses than to rural folk actually on the land. The soil problem, the silt problem, and the flood problem are but aspects of the same general condition. In time of flood it is in the city that heavy loss of life and destruction of property occur. When a dam breaks a few farms will be damaged, but a whole town may be swept away.

Basicly, large and prosperous cities depend on the soil. The family on the land usually survives somehow, even though reduced to a subsistence level, but the very existence of the city depends on surplus food supply, while its prosperity hinges on cheapness of food and on the purchasing power of the food producer as a market. That means efficient soil.

Within the ranks of agricultural engineers, soil erosion threatens every branch of the profession. Gullied fields are no place to operate combines or pick-up hay-balers, even if yields were sufficient to make them economic. As the soil disappears, so does the need for crop storages and animal shelters. Waterpower may generate electricity, but waterpower denuding a farm of soil denudes it also of purchasing power for electricity.

Though it uses machines, power, explosives, concrete, and other structural materials, we are likely to dismiss land reclamation as lacking commercial motivation. In a shortsighted way this is true, but in reality soil protection supports the whole agricultural market and much of the urban market as well. Because we cannot expect the lay public to grasp this fact, it becomes doubly our duty to understand it and interpret it—to become protagonists for our brethren in modern land reclamation.

Soil Erosion Control and Soil Moisture Regulation in Relation to State and National Land-Use Planning[1]

By H. B. Roe[2] *Edited by* William Boss[3]

FLOOD CONTROL, especially in relation to soil erosion control, and the regulation and control of soil moisture within the root zone of crop plants are both fundamental to a permanent and successful agriculture. The consideration of these problems is, therefore, basic to any comprehensive and long-period planning relative to land use.

The major effects of soil erosion as quite generally recognized are as follows:

1. Removal of the virgin top soil without financial return
2. Removal of the fertile elements from the soil at a rate fully twenty times as great as that occasioned by crops removed
3. Ruining of fields by gullying or debris inundation of lower lying lands, injury to or destruction of fences, buildings, crops, and livestock, without financial remuneration
4. Destruction of the natural attractiveness of the region in which serious erosion occurs.

It has been repeatedly pointed out that the soil lost from our fields by soil erosion in the course of an average lifetime originally took nature ages to produce from the parent rock; also that soil erosion can not be wholly stopped, but that it can be checked or controlled to a great extent.

Soil erosion is generally prevalent on the earth's surface and the degree of injury caused by it is approximately proportional to the age of agriculture in the region under consideration.

In Minnesota, even though erosion is held in check to a considerable extent through four to six months of the year by freezing conditions, still examination of the agricultural areas reveals that fifty-one out of the eighty-four counties are affected in whole or in part. In the southern third of the state already the areas injured beyond recall aggregates in the thousands of acres. The area throughout the state where the injury varies from a trace just becoming apparent to a stage beyond economical reclamation, already amounts to several millions of acres. Heavy injury from soil erosion is by no means confined to the eolian and unglaciated areas. As elsewhere, by far the more extensive and serious damage from this cause is due to the form known as sheet erosion—directly concerned with the common practices of farm operation and dependent for its control on a drastic revision of such practices, coupled with the use of specific scientific and engineering practices determined by research.

Underdrainage, more commonly spoken of as "tile drainage," as one phase of soil-moisture control, is largely concerned with the removal of excess or free water from the root zone of plants, thus stimulating better aeration and bacterial activity of the soil and bringing about better availability of the soil moisture actually needed and used by the plants. The optimum condition varies with the type of plant and the type of soil. Nature seldom of herself and unaided takes care of this matter of underdrainage. This problem of producing optimum soil moisture conditions through underdrainage is therefore one of the most important and universal in agriculture, and the principles involved are generally applicable in Minnesota. These principles are, however, but little understood and the present area of tile-drained farm lands in the state is almost negligible. Few of the scientific principles of tile drainage have been worked out in definite form. The Minnesota agricultural experiment station is just publishing as a technical bulletin definite results of studies that show the engineering design of tile-drainage systems required to produce a specific drainage result in a given soil type, and the principles therein shown will be generally applicable on all agricultural areas; but the more important and far-reaching questions as to what constitutes the optimum drainage condition in a given soil *for a given crop,*—a problem involving not only engineering and soil science but also physiologic, pathologic, agronomic, and horticultural science,—is still untouched by specific research. For the best use of land in agriculture it is essential that this problem be solved, and that the facts be generally promulgated and put into practice.

Supplemental irrigation as another phase of soil-moisture control, is principally concerned with the problem of supplying a deficiency in soil moisture during brief critical periods in crop development. Its ultimate purpose, like that of tile drainage, is to produce the optimum soil moisture condition for plant growth and maturity. Contrary to what appears to be common belief, in the upper Mississippi valley, the practice of supplemental irrigation in those areas normally devoted to truck and small-fruit raising is quite as essential to the best use of land in agriculture as are underdrainage and the control of soil erosion. Best practice in supplemental irrigation in humid regions has not been worked out in research beyond a very little by commercial agencies interested in the manufacture and sale of irrigation equipment. A proper land-use program therefore requires that an effective supplemental irrigation code be worked out, promulgated, and put into practice.

Certain natural phenomena, elements, conditions, and groups of current practices are bound up with all the problems of soil erosion and soil moisture control just outlined. The ten more prominent of them are as follows:

- Rainfall (amount and character)
- Topography
- Soil type
- Subsoil type
- Crop type or character of vegetative cover
- Cropping systems (rotations)
- Tillage methods
- Fertility maintenance
- Livestock production and handling practice
- Climate.

A few moments of careful thought over this list makes it clear that the proper solution of the moisture-control

[1]A presentation specially prepared for the consideration of the National Resources Board in connection with its deliberations relative to state and national land-use planning, and based on the experiences of the land reclamation staff of the Minnesota Agricultural Experiment Station in the conduct of official work and on the results of contact with colleagues in other states and in the U. S. Department of Agriculture. Released by special permission for publication in AGRICULTURAL ENGINEERING.

[2]Professor in charge of reclamation activities, division of agricultural engineering, University of Minnesota. Mem. A.S.A.E.

[3]Chief, division of agricultural engineering, University of Minnesota. Charter A.S.A.E.

problem involves the cooperative effort of physiologic, pathologic, agronomic, horticultural, sylvicultural, farm management, soil, and engineering science and practice.

It seems equally clear that a solution through such complete cooperation would go a long way toward a more rational and economic use of land, improvement of crops both in yield and quality, elimination of marginal lands from agriculture, curtailment of useless effort and of economic waste generally, for the maximum effort would be given to the limited area of best land leaving the poorer areas to nature.

Types of Effort Involved

Research must continue to furnish new and to improve the old tried methods of control.

Education of those groups, who in their own business interests should be most vitally concerned, to an understanding of the importance and acceptance of the determined methods of handling these problems must come through the continuing activity of organized technical experts in the public service, by counsel and, more especially, through demonstrations on actual practical projects.

Application, in general farming practice, of the principles of soil erosion and moisture control must come through managerial recognition of the need to use the active services of accredited technical experts in private practice in the carrying out of necessary designs and installations, in directing their operation, and in the maintenance of the installed works.

Agencies Involved

Research. Throughout the United States the states agricultural experiment stations in cooperation with the U. S. Department of Agriculture furnish the centers of organization and in most cases also, potentially, the personnel and financial sinews of research in all of the problems just listed, although in some cases the perception, by the administration at these centers, of the urgency of these problems needs some form of strong stimulus seemingly not now present.

In soil erosion control, in cooperation with the state centers, the federal experiment farms for erosion control conducted jointly by the USDA Bureaus of Chemistry and Soils and Agricultural Engineering in various typical regions of the country are active in the needed research, are doing a good job, and are making the useful facts from research in that field accessible to those responsible for application of the methods determined by research.

Demonstration. The areas being operated as long-time demonstration projects in soil erosion control by the Soil Erosion Service of the U. S. Department of Interior can, without doubt, be made one of the most effective agencies for extending the tried practices of soil erosion control. . . . .

In Minnesota the federal ECW administration—the division of drainage and water of the state department of conservation, acting as the administrator—has, during the past two seasons, started a widespread demonstration service in soil erosion control which, as the problem becomes more and more clearly defined to them, bids fair to become the most effective agency of its kind in the country. However, as this service is recognized to have been established as a purely emergency service, if the benefits already accruing from this work are to be retained and extended, either this service should be perpetuated with continued cooperation by the university department of agriculture or the state agricultural experiment station and extension service should be enabled to take prompt steps to provide for the continuance of this activity and the maintenance of the works already established in case the ECW organization is discontinued in the near future.

In any case the agricultural extension services of the various states should carry on a continuous campaign of demonstration and promulgation of approved erosion control practice. In the fields of soil-moisture regulation and control in most of the states where this problem is recognized, there is no adequate provision for the promulgation of practices based on existing results of research. Here also there exists in the agricultural extension service of the several states the potential centers of organization for carrying on the needed activities, but means for providing the proper personnel is mostly lacking and a stronger stimulus than any yet developed is needed to the recognition of the fundamental and pressing importance of this problem.

Also no work has been done by state agencies in the demonstration of supplemental irrigation in the humid and semi-humid regions; but the growers of small fruits and truck crops have been compelled by the scourge of oft-recurring drought to adopt this method of protection developed from commercial sources only. They surely are as much entitled to customary aids of governmental agencies in this and the subdrainage fields as they are in the fields of pest and disease control. The agricultural extension service in the various states, in cooperation with the corresponding units of the U. S. Department of Agriculture, here also furnish the administrative nucleus from which to develop the machinery for disseminating knowledge of these and the practice thereof.

General Practice and Legal Procedure. The agencies for putting into general practice the principles of soil erosion and soil moisture control are and must continue to be largely the individual farmers, but as such practice in any region frequently shows a definite community of interest among large groups of farmers, such common interest immediately brings into being problems of law, equity, and general welfare, such as public and private rights relative to outlet channels, diversion of waterflow, benefits and damages to individuals and civic units, eminent domain, cooperative effort, the use of public credit and public equipment, etc.

The legal side is pretty well taken care of in the several states in their drainage laws, so far as outlet channels for surface drainage are concerned; but even in the drainage field there is no adequate provision for interior drainage of individual farms through public procedure. When left thus entirely on his own resources, the individual farmer usually has all the financial burden he can carry to meet the assessments for the outlet channel which unsupplemented by interior drainage of his lands outletting therein is a distinct liability instead of an asset.

Furthermore, as yet, no such body of law exists relative to soil erosion control or the use of public waters for irrigation purposes, at least in the eastern and middle western states, and such is now needed.

In fundamental law there is fully as much justification for public participation, loaning of the public credit and provision of public equipment on an equitable basis for private benefit in the fields of interior drainage, soil erosion control, and supplemental irrigation systems as there is in the drainage field making provision of outlet channels for drainage. If not covered in specific language in our constitutions it certainly is amply justified by the clause relative to "promoting the general welfare."

Relation to State and Federal Planning

As a result of intensive observation and research the following facts have become matters of general knowledge:

1 Lowlands capable of proper underdrainage at an

economical figure as a rule are better suited to agriculture than are uplands.

2 Practically all uplands of sloping or undulating surface are subject to more or less destructive erosion.

3 Erosion is far less active on areas covered with forest or other dense vegetative growth than on areas relatively bare of vegetation or used for cultivated crops.

4 Intensity of erosion in a given agricultural area is approximately proportional to the age of agriculture in the region. This fact plainly implies that many current practices in agriculture tend to aggravate erosion. Recent studies of the problem has confirmed this and has pointed out a number of ways in which current practice may be changed to eliminate such deleterious effects.

5 The upper limits of steepness of lands for various uses without undue erosion have been quite definitely determined.

6 Types of crops, crop rotations, cropping and tillage methods, and engineering methods and works have been determined which properly applied or practiced will very nearly eliminate soil erosion on lands not too steep for agriculture. *Reclamation* of much badly eroded land is possible by means of similar procedures.

7 Relative to erosion there are at least three classes of land: those so badly eroded as to be incapable of reclamation within justifiable cost, those capable of reclamation within a justifiable limit of cost, and those still in fair condition which may be kept so by rational treatment.

8 Much agricultural land in the East and Middle West, including Minnesota, is subject to short, sharp summer droughts at uncertain and different periods but all more or less inimical to various types of crops, particularly truck crops and small fruits.

9 Where available, relatively small amounts of water applied at intervals through a short period obviate drought drainage and spell the difference between crop failure and the successful maturing of valuable crops.

10 Instances exist where public waters now allowed to run to waste might be conserved for supplemental irrigation, through community effort at relatively small cost and with assurance of a large percentage of profit on the investment.

Any program involving potential uses of land should be largely predicated upon the foregoing facts as indicating the uses to which various regions can most effectively be put and the relative cost of rehabilitation or transformation for such uses.

Recommendations

In a general contribution of this character it is not possible to make specific recommendations covering all points in detail, but the following are offered as a general guide:

Research. The continued support of well-organized research in the problems herein discussed, cooperative between the different fields of applied science, should be definitely provided for.

Funds for research, both state and federal, should be definitely alloted to the problems discussed in this report, to the end of eventually eliminating submarginal and marginal lands from agriculture and returning such to forest growth, recreation or natural park areas, and to the further end of more intensive cultivation of the potentially more fertile lands, with the general result of better yields and higher quality with less widely distributed effort.

Allotment of funds for such research should make it mandatory on administrative heads to push practical research on these problems with vigor and to make available the fruits of research promptly and in useable form to those who should apply them.

Educational Demonstration. The fruits of research should be definitely and widely carried to the interested public by more thoroughly organized and widespread demonstration areas,—federal and state agencies closely cooperating on a unified program in any given state.

Wherever the county agricultural agent system exists, it should be made mandatory to so extend it as to include agricultural engineering specialists thoroughly capable of carrying out demonstration programs in farm drainage, soil erosion control and supplemental irrigation.

The constructive work in soil erosion control demonstration, such as that carried on by the federal ECW organization in Minnesota the past two years under direct administration of the Division of Drainage and Waters of the Minnesota Department of Conservation, should be more fully recognized and commended, and adequate provision should be made for the continuation, preservation, and maintenance of this work either through its perpetuation as such and by strengthening the effective cooperation between the state department of conservation and the University of Minnesota Department of Agriculture, or by laying upon the University agricultural extension service the future responsibility for this work and by making financial provision for the same.

To the end of increasing its effectiveness, the Soil Erosion Service of the U. S. Department of the Interior should arrange for (1) definite and close cooperation with the state agricultural experiment stations in the several states in the selection of demonstration areas and in fixing the policies for conducting the demonstration, (2) close cooperation between the Service and the soil erosion control experiment station staff of the USDA and adherence to the principles and practices of soil erosion control worked out by that staff, and (3) selection of the staff specialists of the Service on the basis of fitness through the established agency of the federal classified civil service.

General and Legislative. The state drainage codes should be extended to make possible the lending of the aid and credit of the proper governmental unit (county, judicial district, or state) to the individual farmer for the purpose of installing the needed interior drainage on his farm in the same manner as is now provided for outlet ditches—and according to the general plan of the Wisconsin farm drainage law.

A similar plan of public aid and credit should be worked out for the development of supplemental irrigation systems where needed and provision included with proper safeguards for the conservation and collection of those waters now waste and for the use of public waters for such supplemental irrigation purposes.

A whole body of legal procedure for public cooperative effort in soil erosion control along lines similar to the drainage code should be worked out.

Such soil erosion control code should specifically make mandatory provision, through the county or other civil unit, for the needed complete and heavy equipment for mechanical works in soil erosion control, such equipment to be available to the individual farmer for a fair fee calculated to cover the cost of operation and of maintenance and replacement of the equipment based on its accepted life.

A land classification department should be provided for in each state whose function shall be, in cooperation with the state college of agriculture, to keep up-to-date official records of the lands in the state, classified as to their proper natural use of purpose and to conduct a continuous and forceful educational campaign to discourage the use of lands for purposes for which they are definitely known not to be well suited.

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

EARTHQUAKE RESISTANCE OF TIMBER FLOORS, *N. B. Green* and *A. C. Horner*. Engin. News-Rec., 112 (1934), No. 5, pp. 142-145, figs. 4. Tests are reported on the range of earthquake resistance of various combinations of wood floors or roofs and their connections to brick, tile, or concrete walls. The tests included (1) lateral tests of full-size floor panels with varying arrangement of flooring and subflooring; (2) lateral tests of one-quarter-scale model floor panels, first duplicating the full-size tests, and second introducing other variables such as ratio of span to length, size and arrangement of joists with respect to direction of applied load, size and number of nails, size and arrangement of flooring and subflooring, and effect of lapping joists; and (3) tension and shear tests of bolt anchors in brick and tile walls, varying the type, size, and arrangement of anchors, as well as the thickness and mortar mix of both the brick and the tile walls. Only the full-size tests are reported on.

In these tests the expected weakness of single longitudinal flooring was demonstrated as well as the stiffening influence of longitudinal flooring in resisting direct bending stresses. Also a single diagonal sheathing indicated a surprising efficiency in resisting shear forces.

A wood floor panel loaded laterally appeared to deflect in a manner analogous but not exactly similar to a solid wooden beam. This indicates the importance of board length in a floor as well as the importance of adequate nailing in securing stiffness.

A discussion is given of the practical application of the test data.

RELATION OF ELECTRICITY TO POULTRY PRODUCTION: ELECTRIC BROODERS, *L. F. Payne* and *C. A. Logan*. Kans. State Col., 1933, pp. 22, figs. 4. Experiments conducted in cooperation with the Kansas Committee on the Relation of Electricity to Agriculture are reported, the purpose of which was to determine (1) the comparative efficiency of the electric brooder with other types such as the oil and coal-burning brooders, (2) the cost of operation of each brooder, and (3) the relative effects on the chicks.

Comparable results were obtained from all types of brooders. The electric brooder which had an insulated floor beneath the hover proved slightly better than either the coal or oil brooders, while the other electric brooder gave slightly inferior results. The electric brooder required very little time to install and regulate. The oil and electric brooders automatically maintained fairly uniform temperatures with very little care, but the coal stove was hard to regulate. It was necessary to tend the coal fire late at night to prevent the fire from going completely out. Chicks placed under electric brooders required careful attention for the first few days. They must be trained to go under the hover for warmth, and feed should be placed under the hover until the chicks have learned to eat. After the chicks once learned to eat and hunt the hover for warmth the electric hover required little attention.

The humidity is higher with electric brooding than with warm-room brooding. In some instances it was high enough to produce considerable dampness. On cold mornings frost collected on the walls, and as the room temperature increased during the day, water ran down the walls. It was necessary to change the litter in the houses where the electric brooders were used every two or three days during damp weather. The average room humidities for the houses where the electric brooders were used were 70 and 72 per cent, while the average for the coal was 60 per cent and the oil-burning 63 per cent.

Under temperature conditions existing in this test, the cost for electric current at 3 cents per kilowatt-hour was slightly more than coal, about the same as distillate, and would be less than kerosene. When the labor of taking care of the brooder is added to the fuel and energy charges, the electric brooders cost less than either of the other types.

THE USE OF ALCOHOL IN MOTOR FUEL IN FOREIGN COUNTRIES, C. Y. Hopkins. Canad. Chem. and Metall., 18 (1934), No. 1, pp. 2-5. A review of the situation in 1933 in regard to the use of alcohol in motor fuel in foreign countries is presented as a contribution from the National Research Council of Canada.

There are eleven countries in which motor fuel containing alcohol is being marketed. There are two types of legislation in effect in those countries which enforce the use of alcohol in motor fuel. The first requires that all motor fuel sold shall contain a certain percentage of alcohol. The second type requires all importers or refiners of gasoline to purchase a certain percentage of alcohol based on their handlings of gasoline. Five countries use alcohol in motor fuel voluntarily, and the data show that in certain cases blended fuel containing alcohol is cheaper than pure gasoline. This does not necessarily indicate that the cost of alcohol is lower than the cost of gasoline, but rather that the taxes on gasoline are higher than those on alcohol used for fuel purposes. The chief materials used for alcohol production in the eleven countries described are potatoes and cane molasses. Beet molasses, sulfite liquor, wood waste, and grapes furnish most of the remainder of the alcohol.

While the ordinary 95 per cent alcohol is still used in Cuba and in the Philippines, the trend is decidedly in favor of absolute alcohol. It was found in Brazil that 95 per cent alcohol was unsatisfactory, and the law was changed to specify absolute alcohol for future use. Similarly, use of the 95 per cent grade in Natal was discontinued in 1932 and absolute alcohol has been used since that time.

While there was originally a wide variation in the proportion of alcohol to gasoline specified by the various governments, the tendency seems to be to fix the percentage of alcohol at from 10 to 20 per cent of the mixture. Some of the earlier blends used in France and Germany contained from 30 to 50 per cent of alcohol, and it is apparent that lower percentages have been found to be more satisfactory.

FENCES, HEDGES, GATES, SHELTERS, AND STOCK-WATERING EQUIPMENT ON PERMANENT PASTURE (trans. title), *A. Limper* and *R. Limbach*. Schr. Reichskurator. Tech. Landw., No. 45 (1933), pp. 107, figs. 118. A large amount of practical information is given on fence and gate construction, on the construction of shelters, and the selection and development of stock-watering places and equipment.

INDUSTRIAL AND LABOR MANAGEMENT CONSIDERATIONS IN CONNECTION WITH THE USE OF THE TRACTOR IN AGRICULTURE (trans. title), *Derlitzki* and *Nauck*. Schr. Reichskurator. Tech. Landw., No. 46 (1933), pp. 126, figs. 78. This is a report on a management study of the use of the tractor in German agriculture. A large amount of data and information is presented and analyzed relating to tractor adaptation to secure high efficiency and economy in production practices.

TERRACING TO PREVENT EROSION, *E. R. Gross*. N. J. Agr., 16 (1934), No. 1, pp. 6. A brief description of the practice of terracing is given.

SEWAGE DISPOSAL, *W. Rudolfs*. N. J. Agr., 15 (1933), No. 6, pp. 8. Data on sewage chlorination are presented briefly, indicating that ordinarily when no careful control and no large volumes of dilution water are available chlorination up to residual chlorine is safest, but there are many places along the shore and larger rivers where, on account of dilution and with accurate control, partial chlorination may be sufficient. The studies have also shown that different sewages require different quantities of chlorine on account of varying organic substances present.

HOMEMADE FEED MIXER, *H. J. Gallagher*. Michigan Sta. Quart. Bul., 16 (1934), No. 3, pp. 133-136, figs. 2. The development of this mixer is described and the perfected equipment diagrammatically illustrated. Information is given on its operation, and a bill of materials is included.

MULTI-SPEED REDUCTION UNIT WITH DIRECT DRIVE FOR ELECTRIC MOTOR OPERATION, *H. J. Gallagher*. Michigan Sta. Quart. Bul., 16 (1934), No. 3, pp. 130-132, figs. 2. The assembly of this unit is briefly described and illustrated.

RURAL WATER SUPPLY INVESTIGATIONS AT THE MICHIGAN STATION, *W. L. Mallman*. Michigan Sta. Rpt. 1932, pp. 202, 203. The progress results of rural water supply investigations by the station are briefly reported which *(Continued on page 436)*

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RAYMOND OLNEY, *Editor*

Not Less Efficiency, But More

IN A BROAD view of American agriculture over the entire period since the World War, it becomes increasingly clear that the things done in the name of "farm relief" have been largely makeshifts, attempts at temporary palliation. Palliatives have their place in emergency treatment and, as a tender-hearted branch of the engineering profession, agricultural engineers would not let the patient suffer or die for lack thereof. Yet, recognizing as natural law the survival of the fittest, we must take it as our duty to make agriculture fit. We cannot continue indefinitely to be content with a shot of political morphine when the patient's distress threatens to make him violent.

In large degree we have been trying to save the inefficient farmer. That is well enough when an economic cataclysm pushes him suddenly beyond his depth. But there is no sense in defending indefinitely his inefficiency. Our job is to make him efficient; not merely efficient enough to survive and subsist, but to live on an American level, and to do it without subsidy.

Hardly necessary to say, this is no criticism of Secretary of Agriculture Wallace and his leadership. In his address to the American Association for the Advancement of Science about a year ago, in a more recent contribution to "Science," and in his books, he has stoutly asserted the case for efficiency, not alone in the agricultural engineering and other production phases of farming, but in distribution, market appraisal, etc. If anything, we join him against those seemingly irrepressible sophists who offer wasteful, costly farm methods as a way to adjust agricultural production and arrive at farm prosperity.

On the occasion of ASAE annual meeting at Detroit some of us visited the Ford plant. We saw only one assembly line in operation, but it was working at high speed and efficiency—a high yield per acre, if you please. Passing through a deserted tool room, the guide remarked that it had been needed at the high level of motor car demand a few years ago. Possibly the opponents of farm efficiency would have suggested that the second assembly line be started up and both operated at half-speed, to promote prosperity in the automotive industry.

In the idle tool room the machines were well housed, and slushed to prevent rust. Yet no one proposed that these machines be set outside at the mercy of the elements in order to balance the excess productive capacity of the industry—which would be parallel to the idea that erosion control is wrong when there is an apparent excess of farm capacity.

The Ford people are doing, as a matter of course and without clamor from demagogs, precisely what Secretary Wallace and the agricultural engineering profession seek for agriculture, namely:

1 Operating only so much of the plant as is currently needed, and doing it at utmost efficiency.

2 Protecting both the efficiency and capacity of the plant, used and idle, for the future.

At that same meeting President Huntington told us we were more than expert hirelings; that where our special knowledge gives us authority on public issues, it becomes both right and duty to assert our position and assume leadership. We believe efficiency in agricultural production to be no longer a moot question for journalists, not an issue to be evaded, but a vital problem demanding leadership by our profession.

Industrial Outlets for the Farm

MENTION of the Ford name leads into another reason for efficiency in farm production. Industrial outlets for farm products have long been the dream of agricultural engineers and industrial chemists. It may be admitted that the dream thus far has been something of a nightmare, as witness the efforts to make print-paper from cornstalks.

Nevertheless, the amazing march of organic industrial chemistry gives every promise of conquering the technical obstacles that stand between the farm as a producer of industrial raw materials and the factory as a consumer thereof. That Ford is making distributor caps and similar parts from soybean protein, and painting his cars with soybean oil, embodying about a half bushel of soybeans in every machine, is an inkling of what may be done by resolute research and industrial vision.

The real obstacles to industrial markets for the farm are economic. It is one thing to devise a process for making paint from soybeans, or insulating board from cornstalks, as Dr. O. R. Sweeney has been doing at Iowa State College, and another thing to get the raw material produced and delivered to the factory door at costs low enough to make the process commercial and thereby create an industry.

If we ignore international competition for export markets, and measure the home market for farm products entirely in terms of food that the human stomach will hold and clothing fiber that the human back can wear, it may be admitted that the outlet for the farm is rather limited and inflexible. On such a premise there is some justification for emphasizing price and for efforts to keep prices up. But once we admit the possibility of industrial markets, highly expansible if prices are low enough to compete with alternative materials and deliver an economic value to the consumer, the whole picture is changed. Agriculture no longer will be an exception to the rule that industrial prosperity comes through low prices and large volume.

There is a whole system of economics in the fact that the Ford fortune was built on the flivver, not on the Lincoln.

NEWS

Token for Vocational Agriculture Students

THE Department of Agricultural Engineering at Ohio State University, like similar departments in several states, holds each spring an agricultural engineering contest which can be elected by any of those qualifying among the two thousand vocational agriculture students who convene annually at the University to compete in judging and in other skills. The agricultural engineering contest includes work in power machinery, buildings, drainage, and useful farm practices.

For a number of years a silver loving cup has been awarded the school represented by the most successful entrant. To make more awards available, and to enable students to possess some token personally, the Department is now making additional awards, one of which is the charm shown in the accompanying illustration.

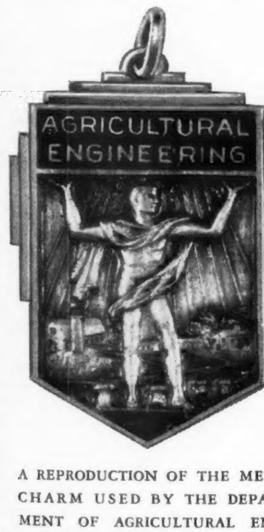
The vocational agriculture student attaining the highest score in the contest receives the cup for his school and a gold charm for himself. A silver charm is awarded the second highest contestant; the third man each year receives a bronze production of the charm; the fourth highest student is awarded a subscription to AGRICULTURAL ENGINEERING, and a suitable book is given the contestant standing fifth.

The charm shows the spirit of youth, superimposed on a farm-scene background, upholding the traditions of agricultural engineering, the inspiration of which radiates to field, home, and farmstead. The letters are metal in a black enamelled setting; and the charms are approximately ¾ by 1⅛ inches.

No emblem manufacturer would take the contract for the charm and its die because the cost of the charm was prohibitive, when the die overhead was added in sufficient quantity to pay out as fast as a commercial house demands. Consequently, the Department of Agricultural Engineering at Ohio State University bought the die outright, and offers its use to other departments at small additional cost.

The plan of awarding a cup supplemented by charms to individuals, and the plan of giving five individual awards, has aroused much interest and is meeting with wide approval in the state.

If other departments of agricultural engineering like the design of the charm and wish to use it in similar awards, they may write to the makers, Ye Auld Crafter, Inc., 243 North High Street, Columbus, Ohio. Permission to use the die will be given to other agricultural engineering departments, for which a charge of one dollar a casting will be made.



A REPRODUCTION OF THE METAL CHARM USED BY THE DEPARTMENT OF AGRICULTURAL ENGINEERING AT OHIO STATE UNIVERSITY IN MAKING AWARDS EACH YEAR TO STUDENTS OF VOCATIONAL AGRICULTURE

Pacific Coast Section Meeting

THE executive committee of the Pacific Coast Section of the American Society of Agricultural Engineers announces that the next meeting of the Section will be held at Oregon State College, at Corvallis, on December 28 and 29. The program for the two-day meeting is being arranged by Mr. M. R. Lewis, chairman of the Section, and promises to be both interesting and varied. The subjects to be featured on the program include the following: (1) Soil erosion control, both research and demonstration; (2) irrigation, dealing with recent findings and their applications; (3) farm structures, buildings, etc.; (4) farm implements and equipment, with particular attention to western conditions. There will also be a dinner talk on the Bonneville Project.

An important business session is scheduled at the luncheon on Saturday, December 29, at which time there will be an election of officers, and a discussion on the "when" and "where" of an annual meeting of the Society in the West.

Personals

J. W. Carpenter Jr., was recently appointed chief agricultural engineer, Mississippi Project SES No. 21, Soil Erosion Service, U. S. Department of the Interior. He was formerly extension agricultural engineer of the Oklahoma A. & M. College.

Eldon M. Collins is employed as engineer foreman in connection with Emergency Conservation Work for Iowa and is located at the ECW Camp, Sidney, Iowa.

Raymond J. Tillotson is assistant engineer in charge of terracing on the Big Creek soil erosion control project of the Soil Erosion Service, U. S. Department of the Interior, located near Lamoni, Iowa.

Southern Section Meeting

THE SOUTHERN Section of the American Society of Agricultural Engineers will hold its meeting as usual at the same time and place as the annual meeting of the Association of Southern Agricultural Workers, which will be held at Atlanta, Georgia, January 30 and 31, and February 1. The Southern Section will present a program of two half-day sessions, which probably will be held on January 30 and 31.

The program for this meeting will be released in the January issue of AGRICULTURAL ENGINEERING.

New ASAE Members

Eugene C. Buier, assistant professor of agricultural engineering, Texas Technological College, Lubbock, Texas.

Forrest R. Gilson, instructor, farm shop and construction, Bristol County Agricultural School. (Mail) 241 Highland St., Taunton, Mass.

Robert J. Reese, engineer, Soil Erosion Service, U. S. Department of the Interior. (Mail) The Gables, State College, Pa.

Geo. E. Spencer, assistant professor in agricultural engineering, Purdue University, Lafayette, Ind. (Mail) 928 N. Main St.

Edwin F. Wadelton, draftsman, Killefer Manufacturing Corporation, Ltd., Los Angeles, Calif. (Mail) 1601 Vineyard Ave.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the November issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Seigel A. Anderson, assistant agricultural engineer, department of agricultural engineering, Purdue University, Lafayette, Ind.

H. E. Besley, instructor in agricultural engineering, Rutgers University, New Brunswick, N. J. (Mail) New Jersey Experiment Station. (Transfer from Junior to Associate Member.)

C. W. Chapman, junior agricultural engineer, Soil Erosion Service, U. S. Department of the Interior. (Mail) Box 596, Athens, Ga.

U. H. Davenport, associate professor of agricultural engineering, University of Georgia, Athens, Ga. (Mail) Box 524.

Hubert T. Heigele, flood control engineer, Forest Service, U. S. Department of Agriculture. (Mail) CCC Camp PE-206, Nebraska City, Nebr.

Henry N. Luebcke, Soil Erosion Service, U. S. Department of the Interior. (Mail) Albion, Nebr.

STUDENT ACTIVITIES

Contributed and edited by A.S.A.E. student members

Minnesota Branch News

ON WEDNESDAY, November 7, the Minnesota Student Branch of the American Society of Agricultural Engineers held a business meeting mainly for the business of discussing plans relative to meeting of the Branch in February, which promises to be one of the most important of the year. At that meeting the students will have the privilege of entertaining members of the Minnesota Agricultural Engineers Society, which is made up of Minnesota engineers, chiefly from the Twin Cities and surrounding territory, who are directly engaged or interested in work related to agricultural engineering.

One of the purposes of this meeting in February is to give the agricultural engineers a better appreciation of the type of training the students receive in their pursuit of agricultural engineering degree. The students will present their ideas to their guests in the form of a skit which will reveal in a measure the character of the work covered in their courses. It is hoped that this presentation will help the guests to better realize the significance of both engineering and agricultural training received by agricultural engineering students. The Minnesota boys would be glad to hear from other branches who have undertaken similar ventures. Special committees have been chosen to undertake the responsibility of directing the presentation of the four main divisions of agricultural engineering, namely: Structures, Electrification, Power and Machinery, and Land Reclamation.

After their meeting in November, the Branch had the pleasure of hearing an address by Dean O. M. Leland of the engineering college at the University, the principal theme of which was the opportunities of employment for agricultural engineers as compared with other engineering groups. —Reported by A. W. Carpenter, branch scribe.

Texas Branch News

THE ASAE Student Branch at the A. & M. College of Texas held its second monthly meeting of the current school year on October 18. This meeting was featured by the election of W. D. Scoates as scribe of the Branch, and by a talk on his travels in the Far East by Mr. Curtiss Vinson of the publicity department of the College.

It is of interest to note that the agricultural engineering department of the College has this year 53 students specializing in agricultural engineering, with a teaching staff of three professors and two graduate assistants.

On October 27 and 28 a party made up of members of the student branch went out to the Scoates farm on the Brazos River for an overnight fishing and hunting party. The venture was a success as the fish and game were plentiful.

The third monthly meeting of the Branch was held on November 8, the program for which featured a talk by Mr Morford of the agronomy department on agricultural methods in the Far East.

News from Missouri Branch

THE MISSOURI Student Branch of ASAE is using a new system for programs this semester which has proven very satisfactory with the members and has helped maintain the increased interest in agricultural engineering built up at the University of Missouri this year. The regular branch meetings are held weekly, in conjunction with the agricultural engineering seminar, a regular curricular course of one hour's credit. Each student in the seminar class is a member of the ASAE branch. The seminar reports, one presented at the first and third meetings of the month, are informative as well as interesting to the agricultural engineer. Each second and fourth meeting of the month is devoted to a discussion led by a faculty member.

The student seminar reports which have been given are "The CCC Work and Erosion Control", "The Tractor versus the Horse on the Farm", "The Two-Story Poultry House", "Terrace Outlets", and "The Stresses and Strains of the Wheel."

This new system solves the program problem of the Missouri Branch.

One week each year the Missouri college of agriculture holds a special session of lectures by professors and discussions on the various phases of agriculture, which would be of interest and benefit to the farmer. This week, October 12 to 17, is called Farmers' Week, and hundreds of farmers representing each county of the state congregated at the college to attend these lectures and discussions.

The agricultural engineering department set up a display of tractors and farm implements. Demonstrations and discussions of these various machines were made by the agricultural engineering faculty. One session of the Missouri Student Branch was devoted to Farmers' Week. Two student talks were given—"The CCC and Erosion Control" and "The Two-Story Laying House", both of which were of interest and information to the farmer.

The Missouri Branch wonders if there is any demand for an honorary ASAE fraternity. Are there not enough students enrolled in agricultural engineering to warrant the formation of such an organization? —Reported by Paul L. Doll, scribe.

News from Ohio Branch

EXPERIENCE talks by members of the Society, lectures by qualified men in cultural subjects, trips to industrial plants, and regular short reports of the most recent achievements in the field of agricultural engineering by various members of the Branch are the activities which will make up the future programs of the Ohio State Student Branch of ASAE, it was decided at their regular business meeting Thursday evening, November 22, in Ives Hall.

While the number of meetings devoted to each was not definitely set, it was decided that social, educational, and cultural programs should be planned. Exact details will be handled by the program committee appointed by the president of the Branch. Committees on arrangements and membership were also appointed at this meeting. The election of a sergeant-at-arms, for which nominations were made at the previous meeting, was also carried.

To facilitate the membership committee in its work, a contest was planned. The Branch was divided into two groups, the losing side being obligated to entertain the winners after the close of the contest, the exact date of which is not yet known.

An effort will be made to have all dues paid by the next regular meeting time. An order for pins will be placed immediately thereafter for all members in good standing who desire the Society's official emblem.

Virginia Branch News

CONSIDERABLE activity is reported from the ASAE Student Branch at the Virginia Polytechnic Institute, the membership of which this year consists of nine seniors, five juniors, and eight sophomores.

In 1932 an elective course in seminar was established, and this plan has afforded agricultural engineers an opportunity to receive information on activities in agricultural engineering, and, at the same time, an opportunity to secure college credit for attending one meeting each week, which is usually of one hour duration.

In connection with this seminar, each senior and junior is required to give one talk each quarter. A schedule of talks was arranged at the beginning of the year, and these talks are given as scheduled and deal with subjects in agricultural engineering and closely related fields.

Freshmen are especially encouraged to attend these meetings but receive no college credit for doing so. Juniors and seniors receive a two-thirds credit hour per quarter and the sophomores—one-third credit hour.

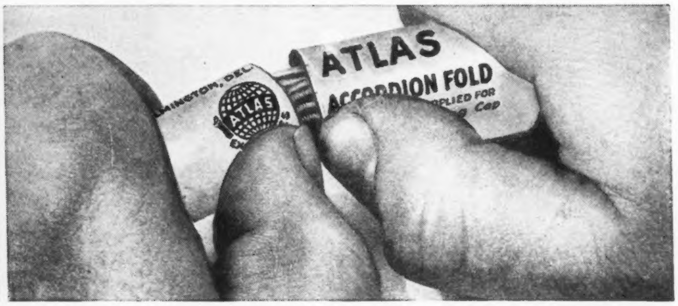
At least one social is held each quarter, the sophomores having charge of the event. They are required to arrange for speakers from outside the Branch and also to provide for refreshments with funds available in the treasury. On October 18 the Branch members attended a moving picture sponsored by the American Society of Mechanical Engineers, entitled "Boulder Dam," this counting as one of the regular meetings. Motion pictures on soil erosion control will be presented by the Branch on November 22, members of the other curricula clubs and the general public being invited to attend.

As indicating the kind of special activities in which agricultural engineering students of VPI occasionally participate, recently eleven agricultural engineering seniors went to White Sulphur Springs to aid in the construction of a recreational resort for sportsmen there. This hunting and fishing paradise is a $100,000.00 conservation project. The students taking the trip were under the supervision of Prof. P. B. Potter, the principal work being to survey a site for a dam, after which they designed the dam which will form a lake covering an area from 50 to 75 acres.

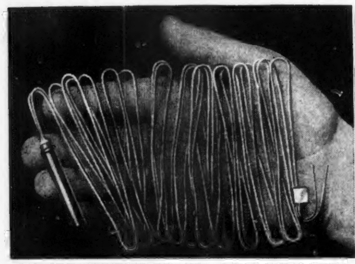
SAFE! CONVENIENT!

The Story of the Handiest, Safest Blasting Cap . . . Told in Four Pictures

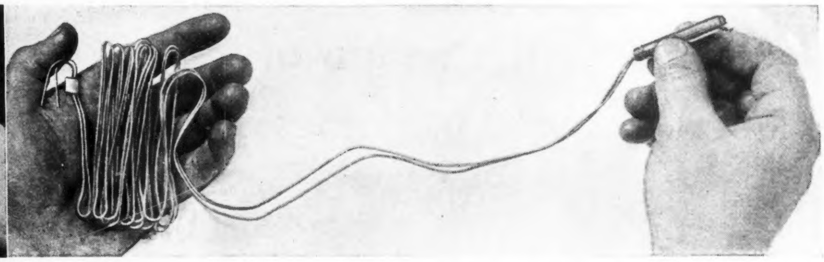
1 The package protects the detonator from external shock. It is handy to carry—and handy to use.



2 The package is easily opened—a simple pressure of the fingers and the package breaks open along the indented line. The tube destroys itself and the cap is ready for use.



3 The wires are kept folded accordion-wise so that they extend naturally into position.



4 It is easy to straighten out the cap end for priming without disturbing the rest of the accordion fold.

HERE are pictures that tell the story of wires folded accordion-wise . . . of folds that are laid around the blasting cap to cushion and protect it at ends and sides. Pictures that show the handiness of carrying—the ease of opening—the round paper tube which completes the package that gives added safety and convenience. The Atlas Electric Blasting Cap itself excels in safety features, dependability, strength and uniformity. Packaged in the Atlas Accordion Fold it is widely and rightly recognized as a particularly important contribution to modern agriculture.

ATLAS POWDER COMPANY, WILMINGTON, DEL.

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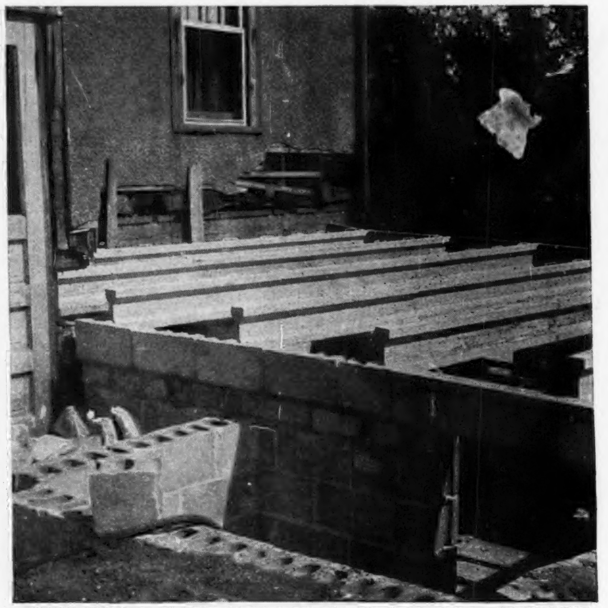
EXPLOSIVES

ATLAS EXPLOSIVES



Widening the range of Concrete's farm usefulness..

precast

Concrete Joists and Floors

Wherever rigid, durable floors are needed, precast concrete joists and job-placed or unit slabs deserve consideration.

Simplicity, economy, ease and rapidity of construction have vastly extended the field for the concrete joist method of flooring. They're ideal for loft floors in barns and in other farm buildings. They are especially practical for floors in farm homes.

Concrete joists are made to fit the job. They're light and easy to handle—weight scales down to 13 pounds per running foot for 8-inch sections if made of light aggregate. And once concrete joists and floors are in, they're in to stay. They provide fire resistance—greater rigidity and durability—lower upkeep.

Specify concrete floors. Send for a free booklet.

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Please send me the booklet "PRECAST CONCRETE JOISTS."

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City.......... *State*..........

Agricultural Engineering Digest

(Continued from page 431)

included examination of wells and other sources of water and experiments on the chlorine treatment of water.

INTERIOR WATER SUPPLY PIPING FOR RESIDENTIAL BUILDINGS, *F. M. Dawson* and *J. S. Bowman*. Wis. Engin. Expt. Sta. Bul. 77 (1933), pp. 54, pl. 1, fig. 24. The purpose of this bulletin is to present a logical method for the design of the interior water supply piping for buildings. It is written primarily for those engaged in such work who lack a knowledge of the theory of hydraulics. While the treatment is from the practical standpoint, a sound theoretical basis is preserved throughout. Data are included in the form of diagrams and tables which represent the results of extensive experiments on friction loss in pipe, fittings, and fixtures which have been made at the University of Wisconsin during the past three years. Illustrative problems and discussions are included which are confined largely to piping for residences of moderate size.

SOIL HEATING WIRE FOR STOCK AND POULTRY DRINKING WATER HEATERS, *H. Beresford*. Elect. West. 72 (1934), No. 3, pp. 23, 24, fig. 2. In a brief contribution from the Idaho Experimen Station data are presented from three years' experiments at the Caldwell Substation on the use of artificial heat in stock and poultry water.

MEASUREMENT OF GLOW IGNITION TEMPERATURES IN HIGH SPEED INTERNAL-COMBUSTION ENGINES (trans. title), *K. Schnauffer*. Ztschr. Ver. Deut. Ingen., 77 (1933), No. 34, pp. 927-931, figs. 13. Experiments are reported the purpose of which was to determine the temperature of glow ignition of different fuel-air mixtures in a high-speed internal-combustion engine. An effort was made to determine the temperature of the exhaust valves necessary to ignite the fuel mixtures during the brief interval when there is no spark. For this purpose a copper stud which could gradually be heated was screwed into the cylinder head of a motor run by external power. The mean temperature of the stud was indicated by a thermocouple. The method made it possible to determine the glow ignition temperatures of benzine-benzol-air mixtures in a running engine accurately to within 5 deg C.

The results showed that the glow ignition temperatures of benzine and benzol in an engine varied only about 5 per cent. The activation energy required to ignite the two fuels varied very little.

However, the glow ignition temperature of benzine was found to be lower than that of benzol under the same conditions, and the glow ignition temperatures of mixtures of these two fuels lay between the glow ignition temperatures of the two fuels when used separately alone.

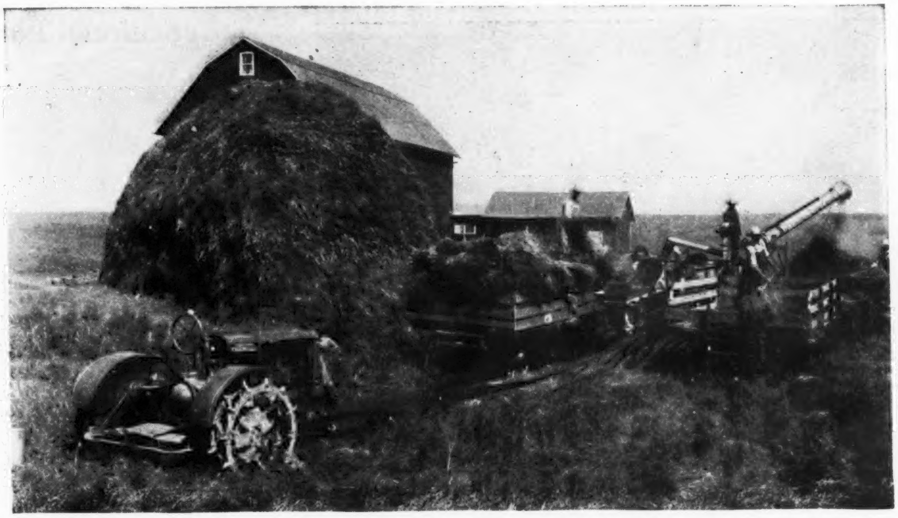
The glow ignition temperature of benzine-benzol-air mixtures increased at full load with increasing speed and was influenced by the compression ratio. This temperature also depended upon the throttle setting, the type of cylinder, and the proportion of residual gas present in the live gas mixture.

POSSIBLE CONSEQUENCES OF USING HIGHLY ANTIDETONATING FUELS IN MOTORS (trans. title), *Bonnier* and *Moynot*. Compt. Rend. Acad. Sci. (Paris), 197 (1933), No. 23, pp. 1388-90, fig. 1. The results of a series of experiments with a variable compression engine of the C.F.R. type using fuels with octane numbers varying from 64 up to 97 are reported, indicating the influence of these conditions on temperatures in the combustion chamber.

It was found that in the zone where detonation is perceptible to the ear the chamber temperature increases with the antidetonating value of the fuel and more rapidly as the compression ratio increases. Outside of this zone, that is where detonation has practically ceased, the chamber temperatures remain practically constant. The temperature decreases naturally with a constant compression ratio and more rapidly than the antidetonating value of the fuel.

The conclusion is drawn that the use of fuels of high antidetonating value does not have the same effect on all engines. Engines which detonate normally show marked increases of chamber temperature when the fuels are changed, whereas engines which are not much subject to detonation such as truck and tractor engines do not show such large temperature variations with changes in fuel.

A HYPOCHLORITE FEEDING DEVICE, *F. R. Shaw*, *R. W. Kehr*, and *E. T. Matthews*. Amer. Jour. Pub. Health, 23 (1933), No. 10, pp. 1075-1080, fig. 1. This device is described and illustrated, and data on its use presented. The principle involved is that of syphoning the hypochlorite solution from a container or containers and delivering it through a stop *(Continued on page 438)*



McCormick-Deering thresher operated by "Farmall" tractor.
Both manufactured by International Harvester Company.

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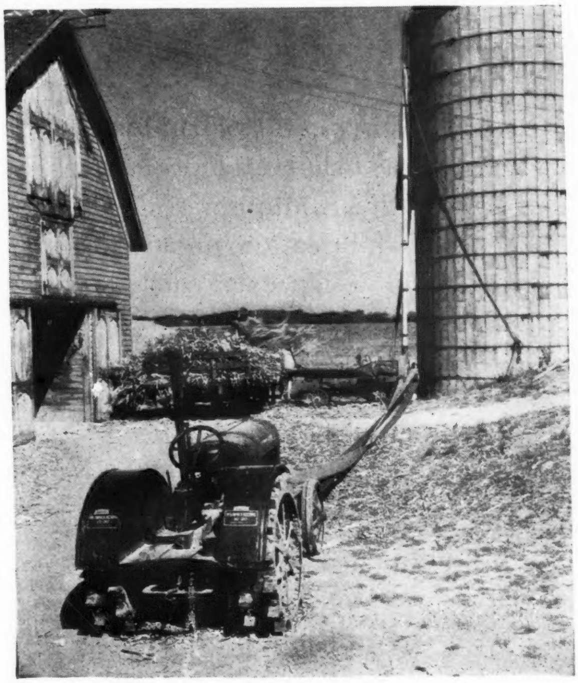
gives farm machinery a longer lease on life!

When you sell equipment
That gives long
And low-cost service
You make a customer
That's hard for competitors
To pry loose

And often the difference
Between long machinery life
And short machinery life
Is merely a matter
Of strengthening
A single vital part

For highly stressed gears,
Shafts, bolts, etc.
Leading manufacturers
Now use Nickel Alloy Steels

For engine blocks, liners,
Brake drums and parts
That are subjected to
Pressure, heat and wear
They use Nickel Cast Irons



Filling silo with McCormick-Deering tractor

The Nickel content
Makes these alloys
Unusually tough and strong
And more highly resistant
To stress, impact, shock,
Abrasion, corrosion and wear

They are not costly—
Neither are they difficult
To fabricate
Our engineers will be glad
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The M-M Harvestor, and Twin City KT Tractor are Twin Disc equipped

MORE Acres a Day

Wherever crops are harvested, Twin Disc Clutches and Power Take-Off Units are transmitting and controlling the power that enables harvesters, combines and tractors to harvest more acres a day—with a minimum of delay for clutch lubrication or adjustment. Better design, extra capacity, positive engagement and release give Twin Disc Clutches that all-around reliability which meets every operating requirement.

Twin Disc Engineers' sixteen years of specialized experience in building agricultural clutches and power take-off units is at your disposal. *Write* for engineering data. Specific recommendations on request. *Twin Disc Clutch Company, 1340 Racine St., Racine, Wisconsin.*

No. 7963 Twin Disc Power Take-Off Unit

TWIN DISC CLUTCHES

Agricultural Engineering Digest

(Continued from page 436)

cock, a capillary tube, and a chlorine-resisting hose to the point of application.

THE PHYSICAL-CHEMICAL PROPERTIES OF ALCOHOL-GASOLINE BLENDS (III, THE A.S.T.M. DISTILLATION CURVES AND REID VAPOR PRESSURE), *L. M. Christensen, R. M. Hixon,* and *E. I. Fulmer.* Iowa State Col. Jour. Sci., 8 (1934), No. 2, pp. 237-244, figs. 3. Studies conducted at Iowa State College are reported in which it was found that the A.S.T.M. distillation data for a fuel can be used as a qualitative measure of the performance of the fuel in a motor. It was found that the initial temperature of distillation of alcohol blends and the temperature of the first 10 per cent distilling are not appreciably changed until alcohol concentrations of 40 per cent or more are reached.

So far as volatility of fuel is concerned, there should be no appreciable difference in starting qualities of the blends containing 10 or 20 per cent alcohol and that of the original gasoline. It was also found that the temperature of volatilization of the first 30 per cent of the fuel is much lower for the alcohol blends than for the original gasoline. The temperature of volatilization of the first 60 per cent of the fuel is very slightly affected by 10 per cent alcohol and depressed approximately 30 deg F by 20 per cent alcohol. In harmony with this fact, very little difference could be observed in the power output of a hot motor when operating on the 10 per cent blend or the original gasoline, and the general observation was that motor operation was smoother on the original blend than on the gasoline. The temperature of volatilization of the last 10 per cent of the fuel was not affected by 10 per cent alcohol, but was lowered by the addition of 20 per cent or more of alcohol. The addition of alcohol to gasoline was found not to alter appreciably the volatility of the low-boiling constituents which would distill over the first 15 per cent of the fuel, leading to the observation that vapor lock will not be encountered on blending alcohol with a gasoline which is itself free from this tendency. Data also are presented on the storage of alcohol blends.

THE PHYSICAL-CHEMICAL PROPERTIES OF ETHYL-ALCOHOL GASOLINE SYSTEMS, (IV, INFLUENCE OF ALCOHOL CONCENTRATION UPON SPECIFIC VOLUME, FLUIDITY, AIR-TO-FUEL RATIO, CALORIFIC VALUE, LATENT HEAT, AND FALL IN TEMPERATURE ON EVAPORATION), *L. M. Christensen, R. M. Hixon,* and *E. I. Fulmer.* Iowa State Col. Jour. Sci., 9 (1934), No. 2, pp. 245-250. Studies conducted at Iowa State College are reported. It was found that systems of ethyl alcohol and gasoline expand on mixing. The maximum expansion is 0.2-0.3 per cent at 4 - 30 per cent alcohol. The density of the 10 per cent alcohol blend is about 0.6 per cent greater than for the basal gasoline. This difference is well within the limits of variation for various gasolines.

Neither the viscosities nor fluidities are additive. Systems containing up to 6 per cent alcohol have lower viscosities and higher fluidities than either the ethyl alcohol or gasoline alone. Up to 20 per cent alcohol the fluidities are greater than calculated on an additive basis, while from 20 per cent up to 50 per cent alcohol, the highest concentration used, the fluidities are less than calculated on the additive basis. The viscosity of the 10 per cent blend is only 3 per cent greater than for gasoline. This is well within the limits of variation for various gasolines. The air-to-fuel ratio of a 10 per cent blend is about 4 per cent lower than for gasoline, while the variation among gasolines may be 5 per cent.

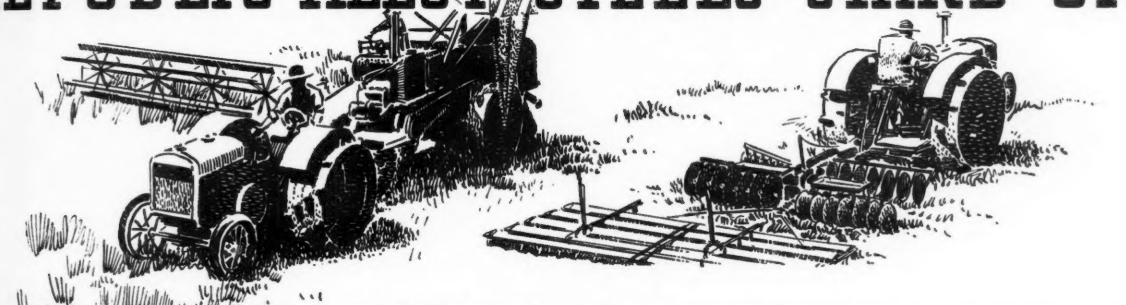
The calorific value of the 10 per cent blend is 3 per cent less than for the base gasoline, while the variation among gasolines may be 7 per cent. Data are calculated for the latent heats and fall in temperature upon evaporation for the various blends. These factors show that with the blends there will be a greater heat input to the intake manifold which is equivalent to an increase in heat content.

All these data indicate that the carburetor setting for a 10 per cent blend should be the same as for gasoline and that the same air-to-fuel ratio would result. This is in harmony with data from dynamometer and road tests.

Literature Received

FINDING WORK. There was published in the November issue of "Mechanical Engineering," the monthly journal of the American Society of Mechanical Engineers, an article, entitled "Finding Work," by Samuel S. Board, which is designated "a standard technique applied to needs of engineers." The author of this article is a placement specialist of New York, and it has been reprinted in pamphlet form and may be secured from the ASME, 29 West 39th St., New York, N. Y., at 10 cents per copy. The pamphlet deals with a problem of paramount importance to unemployed engineers in all fields, and contains constructive, helpful suggestions which engineers can use advantageously.

REPUBLIC ALLOY STEELS STAND UP



Probably no piece of agricultural machinery encounters more severe service than the tractor. Gears, bearings and drive shafts must have more than ordinary strength and resistance to wear. Axles must be unusually strong and be able to resist shock. Bolts, connecting rods and various structural parts must be strong enough to resist stresses caused by use and abuse.

Thousands of tractors in use today have built good-will for the name they bear, because these vital parts are made of Republic Alloy Steels. Thousands more will continue to do the same thing next year and in the years to come, because Republic research in the making of fine alloys goes on and on to keep pace with the needs of manufacturers and users of agricultural equipment.

CENTRAL ALLOY DIVISION . MASSILLON, OHIO

REPUBLIC STEEL CORPORATION

GENERAL OFFICES R YOUNGSTOWN, OHIO

A 20-Year Record of Farm Machine Improvements

HAVE FARM MACHINES shown marked improvement in quality during the past two decades? The statisticians of the federal government wanted to know. The farm trade was ready to be shown. The agricultural engineers wanted the improvement recorded. Even the manufacturers, who claimed they had made such progress in producing a better product, wanted to know in detail, step by step, and in black and white, what they had actually accomplished. And this is what happened:

1 Arrangements were made to have three well-known agricultural engineers make a disinterested, authoritative study of the engineering development and improvement of twenty-five representative farm machines during the past 20 years. Dr. J. B. Davidson, Iowa State College; Prof. G. W. McCuen, Ohio State University, and Prof. R. U. Blasingame, Pennsylvania State College, are the three engineers who made this study.

2 Not only did these agricultural engineers carefully examine and note the contrast between the farm machines of twenty years ago and those of today, but they also reviewed and recorded step by step the progression leading to the changes made. Also, instead of dealing merely with the machines under consideration as whole units, they examined as well the evolutionary changes in every part of the machines they studied. There was a total of 13,318 items in the 25 machines under consideration, including bolts, rivets, etc.

3 The results of the study were published in a 168-page book (8½ x 11 in), entitled "Report of an Inquiry into Changes in Quality Values of Farm Machines Between 1910-14 and 1932," which includes 64 full-page halftone illustrations showing graphically the changes that have taken place in the principal agricultural machines, and in their working parts.

The report is in four parts, as follows: Part I sets forth the purpose, scope, and conclusions of the inquiry. Part II is a chronological record of important changes in each of the 25 machines during the past 20 years. Part III exhaustively discusses changes in materials used in the manufacture of farm machinery. Part IV contains a direct comparison in detail—by both text and illustrations—of machines of the 1910-14 and 1932 periods.

4 The report of this inquiry was published by the American Society of Agricultural Engineers from which copies may be purchased singly or in bulk.

* * * * *

The price of the "Report of an Inquiry into Changes in Quality Values of Farm Machines Between 1910-14 and 1932," is 50 cents per copy (postpaid), on orders of one to twenty-five copies. Special prices will be quoted on orders for larger quantities. Place order direct with

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

SAINT JOSEPH MICHIGAN

EMPLOYMENT BULLETIN

An employment service is conducted by the American Society of Agricultural Engineers for the special benefit of its members. Only society members in good standing are privileged to insert notices in the "Men Available" section of this bulletin, and to apply for positions advertised in the "Positions Open" section. Non-members as well as members, seeking men to fill positions, for which members of the Society would be logical candidates, are privileged to insert notices in the "Positions Open" section and to be referred to persons listed in the "Men Available" section. Notices in both the "Men Available" and "Positions Open" sections will be inserted for one month only and will thereafter be discontinued, unless additional insertions are requested.

Men Available

RURAL ELECTRIFICATION ENGINEER with bachelor's degree from an eastern state college (1928) now employed by one of the largest public utilities in the East, desires a change of location. He is experienced in all farm operations, thoroughly understands rural problems, has had six years' experience in rural electrification, and has also taken the rural electrification course offered by General Electric Company. He would be interested preferably as rural electrification engineer with a public utility, in experiment station research work, with an equipment manufacturing concern, or as a graduate assistant. Age 29. Single. Will go anywhere. MA-253

AGRICULTURAL ENGINEER desires employment in soil erosion control work, soils, drainage, or any other phase of land reclamation. He is a 1915 graduate in forestry of the University of Washington; has had extensive experience in land clearing, drainage, and heavy construction work; has made an intensive study of soils, drainage, etc., and for the past ten years has been engaged in private professional practice as a civil and landscape engineer, and is a registered civil engineer and land surveyor in the states of New Jersey and New York. Age 40. Married. Prefers location in the East, but will go anywhere. MA-254

AGRICULTURAL ENGINEER with bachelor's degree in mechanical engineering and in agricultural engineering, and a master's degree in engineering, graduating with high honors from University of Wisconsin. For 18 months and at present camp superintendent on federal erosion control CCC camps in Wisconsin and Illinois in charge of concrete and construction work for erosion control and land utilization directing 220 men and 10 engineers. Assisting instruction work during graduate work at University of Wisconsin, three years' research and experimental engineering and design of all sizes of Diesel engines with America's largest builder. Two years' graduate research on small grain grinding. Best of references. Desires more permanent connection with work requiring man with excellent contact ability, sales engineering, insurance company, industrial firm. Age 27. Location not important. MA-256

ENGINEER, experienced on extensive mapping projects, drainage projects, construction projects, and the building of railroads in connection with sugar estates, also experienced with sugar mill and heavy construction and with all forms of hoists, etc., desires employment where his experience may be used. Will go anywhere, but prefers the tropical countries. MA-257

AGRICULTURAL ENGINEER, graduate of Iowa State College, and experienced in the design and promotion of ready-cut farm buildings and building lumber and in the manufacture and testing of certain materials, desires position in farm building or utilities field with agricultural college, federal project, or commercial concern. Reared on farm. Age 26. Married. Employed at present. MA-258

Position Open

AGRICULTURAL ENGINEER (graduate) wanted with practical experience in the planning of farm buildings, including heating and ventilation. Must have ability to address public gatherings, instruct, and sell. PO-102

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